Exhibit 4

AFFIDAVIT OF REAR ADMIRAL DAVID P. SARGENT, JR.

In Support of Removal in RE:

Joseph Salerno and Carolyn Salerno v. Aerco International, et al., (190133-12) New York County, New York

Pasquale A. Forgione and Ann Forgione v. Air & Liquid Systems Corporation, et al., (190216-12) New York County, New York

Silas C. Booth Jr. v. Air & Liquid Systems Corporation, et al., (190171-12) New York County, New York

Coburne Miller and Diomaris Miller v. Air & Liquid Systems Corporation, et al., (190148-12) New York County, New York

John Logan and Gail Logan v. A.P. Moller-Maersk, Inc., et al., (190203-12) New York County, New York

Patricia Curren, Executrix of the Estate of John Curren and Patricia Curren in Her Own Right v. Air and Liquid Systems Corp., et al., (3953) Philadelphia County, Pennsylvania

Andrew Jackson v. A.O. Smith Corp., et al., (2992) Philadelphia County, Pennsylvania

AFFIDAVIT

DAVID P. SARGENT, JR., being duly sworn, deposes and states under the penalties of perjury, as follows:

Background and Experience

1. I am a retired Rear Admiral of the United States Navy, in which I served between 1967 and 1999. I began my active naval career in 1967 after receiving a Bachelor of Science degree in Mechanical Engineering from Cornell University and receiving a commission in the Navy through the Naval ROTC program. Upon commissioning in the Navy, I attended the Cruiser-Destroyer Forces Pacific Fleet Engineering Officer's School in a course focused on the operation and maintenance of engineering plants of World War II era warships. In 1974, I received a Master of Mechanical Engineering degree from the Naval Postgraduate School, Monterey, California. In addition, I am a licensed Professional Engineer (Mechanical) with extensive operational experience in ship engineering, ship maintenance and at-sea operations.

2. My assignments from 1967 until 1988 were primarily involved with the operation and maintenance of Navy warships. Thereafter, I held a variety of program and technical management positions in the Naval Sea Systems Command program offices where I was responsible for the design, construction, fleet introduction, in-service support, and modernization of various classes of warships. Upon selection to Rear Admiral in 1994, I was assigned as Commander, Naval Surface Warfare Center, a diverse organization of research laboratories and engineering stations responsible for research and development of all technical aspects of Navy surface ships and submarines. My final assignment before retirement in 1999 was as Program Executive Officer for Aircraft Carriers, Expeditionary Warfare and Auxiliary ships. In that position, I had overall responsibility for all matters relating to both the technical and programmatic details of design, construction, delivery and support of both new and in-service aircraft carriers, expeditionary warfare and auxiliary ships of the Navy.

3. I am now the President of Sargent Enterprises, Inc. which includes several business units: SEI Associates, a consulting business that provides technical and management advice to marine industries; SEI Marine Technologies LLC; a company that operates and maintains various test and demonstration craft for R&D companies involved in developing new equipment and hull forms for future high performance ships, SEI Vistas LLC that is focused on the introduction of innovative durable construction technologies for maritime related uses, and SEI Properties LLC, a business unit involved in the management and renovation of rental properties, I have served for many years in active leadership of the American Society of Naval Engineers (ASNE) and in 2001 was elected to serve as President ASNE, and served two consecutive two-year terms. I continue as an active member of ASNE leadership. I am also a member of the Sigma Xi Engineering Honorary Society, the American Society of Mechanical Engineers, The Cornell Engineering Alumni Association, the U.S. Navy League and several other professional societies. I serve on the Board of Directors of the Maritime Technology Alliance.

4. As a Navy engineering officer and program manager, I was often called upon to assist in determining conformance of shipbuilders and equipment vendors to drawings and specifications prior to acceptance by the Navy. The chain of command within the Navy concerning ship design and construction involves several layers of authority, particularly in the lines of command for technical and contractual control over Navy ship design, construction, maintenance and repair. Ultimately, the Secretary of the Navy has authority over the Navy including Navy shipbuilding design, construction and operation. During the 1940s, 1950s and 1960s, the Navy Bureau of Ships (BUSHIPS) (later known as NAVSHIPS and currently as NAVSEA) controlled all Navy ship design and construction.

5. I am knowledgeable from my own Navy service, and also from my education, training, research and experience with the historical practices and procedures employed by the Navy in the design and construction of vessels and the operation of its vessels and facilities.

The Military Environment on Navy Warships is Unique

6. The military setting on Navy ships is unique and distinct from the civilian environment, and also differs somewhat from that of land based military organizations. All have management structures, but the military command hierarchy of rank is well defined and the accountability and authority of the Navy ship's Commanding Officer approaches absolute. This authority is based in Federal statute, as well as in Navy Regulations and Instruction. Over time, there have been evolutionary changes in these to incorporate changing societal values, but the authority of the individual in command remains constant. When routine "orders" are given, prompt and appropriate response is expected. The failure to obey a lawful order is a punishable offense and, depending upon the situation (wartime, national emergency, misconduct), the punishment can be severe. Individual freedoms that are common to civilians are not as universally applied to military members. Civil liberties indeed exist, but they are tempered to the strict Uniform Code of Military Justice (UCMJ) and the requirements of individuals serving in the Country's national defense. Military personnel are required to wear uniforms with rank

insignia, and to maintain strict physical and grooming standards. Military members ask for permission to leave the presence of a senior in a normal setting, and juniors initiate salutes when in uniform. Although the actual work tasks and duties performed by Navy sailors may be similar to some civilian trades, naval uniformed personnel are not civilians "doing their job".

7. The normal day in the military also differs dramatically from the civilian environment. Whereas civilians have a "normal work day" of 8 or so hours and then return to their "private life", in the military the "work day" is 24 hours long. Here again that 24 hour day is unique for Navy personnel on ships for several reasons. First, a warship is the only weapons system in which the operators live. Armies live in barracks or tents, store their weapons in ammo magazines, and conduct their daily military tasks in locations separate from both of those. On Navy ships, the ship is the "barracks", the "magazine, the "weapon", and the military "work site", and is continuously in motion on the oceans of the world. Thus, sailors on a Navy ship must continuously operate the ship's propulsion system and "hotel services" equipment that make the ship safe and livable, but must also spend a "military work day" focused on training and maintenance of the "weapon systems" to be battle ready. These two requirements are done concurrently on ships through a "watch bill" in which personnel operate the ships on a twenty-four hour basis, and a "work day" of approximately eight hours. The "watch bill" is typically comprised of four hour "watches" during which the "engineers" operate the propulsion, electrical generating, and other systems that make the ship mobile, safe and livable, the ship's officers and "deck force" stand navigation and ship control watches on the bridge, and the "operations crew" continuously operate the ships radars, communications, and other electronics equipment. There are typically three "watch sections", thus allowing the personnel to be "on watch" for four hours, and "off watch" for eight hours. Those watch sections in an "off watch" status during the daylight hours use that time to accomplish the "military work day" focused on training and readiness of the war fighting equipment. Thus, a typical day for a sailor on a Navy ship includes two four hour "watches" and up to eight hours of "military work". In addition to the concurrent "watches" and "military work", a Navy ship typically conducts "underway replenishment" every

three or four days. During these "underway replenishments", warships rendezvous in close formation with Navy oilers, ammunition ships, and food cargo ships and transfer large quantities of fuel, ammunition, and food to that are needed to keep the ship operating and battle ready. These "underway replenishments" typically take three to four hours to complete, and require "all hands" to be involved to operate the special equipment and to handle the food, ammunition, and cargo coming aboard. These "underway replenishments" can occur at any time of the day, and are often done in the middle of the night. Therefore, a Navy sailors' "typical work day" is very busy with "watches", "work", and "special evolutions" such as replenishment.

Navy Warships are Unique and Complex

8. Warships must be designed to meet very demanding performance requirements such as high speed and firing of weapons, the ability to safely carry and employ a vast array of explosives and ammunition, the ability to operate for long periods at sea without support or replenishment, and do all these missions both in peacetime and in combat.

9. Navy warships are some of the most complex machines ever designed and constructed. They are high-speed, floating, heavily armed communities that must support hundreds of crew members and a vast array of complex systems for months at sea. Ships are the only machines sufficiently large, complex and mobile that the operators must live inside the machines they operate. Thus, warships of all sizes and types contain all the facilities of a community plus multiple the armaments and ammunition. Major characteristics and capabilities include a sturdy and survivable hull form, high performance propulsion systems, electrical power generation to support all needs, fresh water distilling systems, food storage, preparation, and eating spaces as well as clean up, living spaces, laundry services, medical spaces, library, firefighting and damage control capabilities, and many other services.

10. An example will help to illustrate the immense task faced by the Navy in designing warships. Among the vessels constructed by the Navy during the general period in

question were the so-called *FORRESTAL* class aircraft carriers. These ships were designed and constructed during the 1950s and served the Navy into the 1990s.

11. The *FORRESTAL* class carriers were 1,063 feet long, with an extreme width of 252 feet. They displaced about 80,000 tons. Their draft, or depth below the waterline, was approximately 37 feet (about the height of a 4 story building). The overall height of the ships was greater than the height of a 25 story building, and they had 19 different "levels" or floors. The flight deck from which aircraft took off and landed was approximately four acres in size, and the hangar bay consumed an additional two acres. The vessels had approximately 3,000 separate compartments or rooms, ranging in size from small offices to engineering spaces the size of gymnasiums. The onboard storerooms were equal in size to a six-story building. It took about 300,000 gallons of paint to paint the entire ship. There were multiple large food preparation and serving areas to feed the crew around the clock.

12. The *FORRESTAL* class carriers were capable of speeds in excess of 30 knots (about 36 mph), produced more than 200,000 gallons of fresh water a day by distilling salt water, and carried several hundred-thousand gallons of ship and aviation fuel. Each had eight large turbo-generators that produced enough electricity to power a good sized city. The Navy estimates that the ships had more than 10,000 miles of electrical cable installed and many miles of piping the ships carried more than 80 aircraft each, and they had crews of more than 5,500.

13. Navy warships must be designed to operate effectively in very harsh and hostile environments, to survive battle damage and fight again, and to meet demanding speed and maneuvering requirements. Over time, the specific types of enemies, weapons and combat which Navy ships must face has changed, from a focus on surface-to-surface combat involving heavy guns to greater use of aircraft and missiles. These changes have created fundamental changes in the design and construction of Navy vessels.

14. Beginning in and following World War II, the aircraft carrier became the most significant type of surface ship. An aircraft carrier must use high speed to create wind over the deck to launch and recover aircraft. The result was an overall increase in the speed demanded of

Navy vessels of all types, whether carriers or the support and escort vessels that accompany them. To meet these demands, Navy designers had to develop significantly higher horsepower propulsion plants. It was also imperative that this increased power be achieved without significant increase in either the size or the weight of the propulsion plant, since increased size and weight would require even more horsepower.

15. The unique aspects of Navy warship design and development placed other requirements on the Navy establishment. Since there was no U.S. industry that either designed or assembled these high performance propulsion plants, the Navy had to undertake itself the design of these complex and state-of-the-art warships, and had to develop ways to verify the performance and reliability of these new designs. To accomplish this, the Navy maintained an engineering establishment with many different engineering specialties. The Navy had the most diverse and advanced engineering workforce in the nation. Additionally, verifying the performance of these new propulsion designs required that the Navy engineering organization build large shore-based laboratories in which they assembled and operated prototypes of these propulsion plants. These prototypes served many uses including verifying performance, validating reliability, and developing optimum operating procedures.

Navy Vessels - Concept to Operational- The Process

Cost and Feasibility Studies

16. Prior to the 1940s through the 1970s, the design of Navy warships started with the establishment of naval war fighting requirements at the national level. Examples included requirements such as the need to ensure that sea lanes in international waters cannot be denied by an enemy, the need to detect and neutralize hostile ships, submarines, and aircraft that might threaten U.S. or allied coasts, the need to transport and operate aircraft near enemy territory, and the need to transport and debark Marines anywhere in the world. From requirements such as these, various ship concepts were formulated.

17. Rigorous feasibility studies were done on these concepts by both seasoned naval operators and by experienced ship engineers and designers to validate and mature the concepts, and to develop initial cost estimates for budgeting and congressional funding requests. A final ship concept design emerged, describing such parameters as approximate physical size and displacement of the ship, what weapons and sensors would be used aboard, what speed it was required to achieve, what range it must be able to achieve without refueling, and how long it must operate at sea without replenishment. Typically, it took a year or more to progress from a defined new warship requirement set to an agreed to concept design to meet those requirements.

Preliminary Design

18. The next step in the creation of a new warship during the time periods in question was the conversion of the concept design into a preliminary design package that contained sufficient details of the structure and all ships systems to allow engineers to verify that the ship would meet established requirements. During preliminary design Navy engineers determined all equipment arrangements, the weight and stability of the ship, a detailed understanding of the ship's displacement and powering requirements, and a much better cost estimate. Work included investigation of details such as identification of what materials and technologies existed or could be developed in time to achieve the performance of each system, and ensuring that these technologies and design details could in fact be manufactured and integrated into a completed warship.

19. The preliminary design phase was accomplished by dividing the very complex ship into many groupings and sub-groupings such as hull design, propulsion, electrical, deck equipment, messing and berthing, medical, navigation, weapons, sensors, and auxiliary systems to name just a few. During this preliminary design phase, engineers had to develop and document the performance, configuration, and location of each system and piece of equipment that is required to meet the overall ship performance requirements.

20. The preliminary design also had to comply fully with extensive Navy warship design General Specifications and other design guidance developed over many decades of experience. Examples include aspects such as how much damage the ship must be able to experience and still remain operable, what levels of shock from battle damage equipment must withstand and remain operational, and what firefighting and damage control capabilities must be included in the design. At the completion of the preliminary design and related documentation, the Navy was confident that the ship and all included systems and equipment would function as designed and would meet the war fighting requirements.

21. Although the time to develop a preliminary design varied greatly depending on the size and complexity of the warship, typically for a destroyer-type warship, the preliminary design required six months to a year and thousands of man-years of engineering work.

Development of the Contract Design package

22. The next phase in progressing from a ship design to an operational warship was the contract design process, in which the preliminary designs were converted into documentation of proper format and sufficient details for use in the government acquisition contracting process. In essence, this effort was to "design" the procurement contract.

23. The complex ship systems and subsystems described in the preliminary design were typically comprised of a myriad of individual mechanical and electrical components connected together in intricate ways. During the contract design phase, Navy engineers had to confirm that sources exist from which the specified materials, equipment, and consumables could be obtained. However, usually there was no one source from which the Navy could obtain these complex warship systems and subsystems. Rather, sources had to be identified for individual components that can later be assembled into the Navy's complete systems. Thus, the Navy typically had to procure, for each vessel, countless individual components from dozens of individual suppliers and sources. Examples of components associated with just the propulsion systems on Navy warships include specific types of steel and fasteners, pipe and fittings; valves,

pumps, turbines, condensers; electrical motors, generators, and switchboards; gauges, meters, alarms; boilers, condensers and reduction gears. During World War II and well into the 1960s, virtually all equipment that was to be installed in warships was procured by the Navy and provided to the building shipyard as government-furnished equipment.

24. This detailed design of all equipment, subsystems, systems, and the entire ship had to fully comply with a plethora of Navy design guidance developed from previous experience. For example, the Navy set and followed internal standards and requirements regarding such matters as levels of redundancy necessary to preclude single points of failure, standardization of consumables and spare parts amongst different equipment and systems, and across warship classes, crew operating environmental requirements such as temperature, noise, lighting, equipment labeling, standard Navy identification and labeling of decks, doorways, compartments, and equipment, and housekeeping matters such as heating and ventilation, food storage preparation and serving, and laundry requirements.

25. The contract design package when complete included the entire set of Ship Specifications with detailed design information, the contract plan for procuring all equipment as well as contracting for ship construction, and the multitude of individual requests for proposals that were required to describe every piece of material, equipment and subsystem that had to be procured to allow construction of the warship. The development of the contract design package involved multiple government decisions. Examples include decisions which were subject to various Navy and other federal guidance and regulations, such as Federal Specifications, Federal Acquisition Regulations and Defense Federal Acquisition Regulations.

26. The Navy developed specifications called, since the 1950s, Military Specifications (MILSPECs) for use in the contract design package. Thousands of MILSPECs were developed for various specific materials, equipment, components, books, manuals, label plates, etc. These MILSPECs presented very detailed descriptions of what the government required when procuring the items covered by the MILSPECs, including requirements such as chemical composition, dimensions, required testing and performance demonstrations, required

labeling, packaging and shipping requirements, and similar content. These specifications typically cross-referenced and invoked other specifications.

27. The Navy maintained the responsibility to develop the MILSPECs and other standards for the manufacture and supply of equipment used in the construction, maintenance and repair of Navy ships. Specifications for any equipment intended for use aboard Navy ships were drafted, approved and maintained by the Navy. Once promulgated, only the Navy could make changes or modifications to those specifications. MILSPECs were prepared by hundreds of Navy engineers highly qualified in specialty areas such as, among many other things, valves, pumps, steam turbines, gas turbines, reduction gears, ship propulsion, and auxiliary equipment. Examples of specifications for the types of valves at issue in these cases are attached hereto as Exhibit A.

28. This specification system was initiated in the 1930s and was expanded in both scope and detail for use in the procurement of the large number of complex warships procured in the World War II timeframe and since. The technical specifications system always included a disciplined revision and change process to ensure technical specifications were kept current and reflected changing requirements, technology, materials, and other related updates. Manufacturers of components, such as valves and pumps, procured by the Navy for use in warships were required to comply with technical specifications in all details in order for the Navy to accept the equipment being manufactured, tested, and shipped.

29. Navy specifications were communicated to vendors when the Navy (or private entities, such as shipyards or design professional firms) issued Requests for Proposal (formerly called Invitations for Bid) for the manufacture or supply of certain equipment. Compliance with the standards and specifications issued for equipment supplied for ultimate use aboard Navy ships was directly monitored by Naval Machinery Inspectors under both of the following divisions: (a) Machinery Inspectors under the Bureau of Supplies and Accounts worked on-site at vendors' facilities, and (b) Machinery Inspectors under BUSHIPS carried out their responsibilities at the shipbuilding yards. The Machinery Inspectors ultimately worked for the

Secretary of the Navy or the Secretary of War. These Inspectors exercised primary, front line control and direction over the work performed for the Navy by original equipment manufacturers, regardless of whether the equipment was being constructed or supplied pursuant to a Navy or private contract. The Navy required in process testing and approval. For example, shock testing, balance testing, vibration testing, tolerance measurements, endurance testing, radiographic testing, etc., were reviewed at the manufacturer's facility and approved by the Machinery Inspectors before the equipment was shipped. Compliance with the testing requirements necessitated unique design and engineering to ensure the necessary strength and durability of the equipment for battle conditions. Equipment could not have been installed aboard Navy vessels unless it was first determined by the Navy to be in conformity with all applicable Navy specifications. The Navy required equipment manufacturers to supply drawings and plans, which the Navy would approve and sometimes revise or comment on before equipment was constructed and shipped.

30. The incredible level of detail contained in these specifications is necessary to ensure complete and common understanding between the government and vendors of what it is the government is requires and is committing to pay for, to ensure commonality across systems with similar components, and ensure that replacement parts, equipment and consumable materials, some provided by different manufacturers, will all perform as desired. An acquisition contract typically invokes many different MILSPECs, various technical documents such as drawings prepared by the Navy's Bureau of Ships. Taken together, the contract and the incorporated materials present all details of what the Navy requires. It is through this detailed acquisition process that misunderstanding, or rejection at the time of government acceptance inspection, is avoided. This process also minimizes contract disputes between the government and industry vendors.

31. Developing the contract design package is comparable to the effort required if a team was to simultaneously develop the detailed designs and contracts to construct a small city including all the required services such as utilities, hospitals, restaurants, and the like. Because

of the complexity and thoroughness required, development of the contract design package for a warship such as a destroyer typically took two years or more to complete, with thousands of man-years or effort from engineers, logisticians, contract and legal specialists.

Detailed Design

32. From the 1940s through the 1970s, the next step in the creation of a new warship was the conversion of the contract design into detailed design package that contains sufficient details of the structure and all ships systems to allow the building shipyard to build the ship and integrate all specified equipment in accordance with Navy requirements and specifications. The detailed design was typically accomplished by the construction shipyard - whether a Navy yard or a private yard after the construction contract was awarded. During this detailed design phase, engineers had to develop and document in detail the exact location, mounting details, and interface details of each system and piece of equipment in the total ship. Even where not performed by Navy personnel, the detailed design was also overseen by Navy representatives. Pursuant to those design plans and specifications, the shipyard connected an array of components such as valves, pumps, boilers, turbines, generators, and other equipment to pipes by adding gaskets to the flanges of each piece of equipment and piping. Where flange gaskets contained asbestos, it was because the Navy required it; the manufacturers of valves and pumps did not manufacture or supply the flange gaskets.

Warship Construction

33. The final phases in getting the warship operational included the construction, testing and trials, and acceptance by the Navy. During World War II and up until the mid-l 960s, some Navy warships were constructed at Naval Shipyards and others were constructed at private shipyards under Navy contract and supervision. Once the Navy selected a construction shipyard, that shipyard was required to comply with all details of the contract in the procurement of material and equipment, the construction of the ship, the testing of equipment, subsystems, and systems and the demonstration to the government that all systems functioned properly. All

construction and testing was overseen on a daily basis by the on-site Navy Supervisor of Shipbuilding team. Formal acceptance of the completed warship was recommended by the Navy Board of Inspection and Survey only after the members of the Board had witnessed successful sea trials of all systems.

34. Construction of even a relatively small warship such as a destroyer typically took three to five years, with larger ships requiring somewhat longer. During World War II, the construction time for warships was dramatically reduced through the concerted efforts of both the Navy and the industries involved. The Navy, working with the War Production Board, instituted standardization of warship designs, central procurement of ships' major equipment, propulsion machinery, and ordnance, and allocation of key materials. Industry went to twenty-four hour workdays with multiple shifts, prefabrication and automation of many processes, and multiple other time saving methodologies. The Navy and the U.S. Maritime Commission worked closely with the shipbuilding industries and increased the number of shipyards capable of constructing destroyers and larger ships from approximately a dozen in 1940 to around 70 in about two years.

Asbestos and Insulation in the Navy

35. As described above, the Navy requirements for aircraft carriers and other warships of World War II and later included the need for significantly higher speeds than previously. This high speed required was achieved by the design and development of sophisticated high-pressure steam propulsion systems. Steam pressures of 600 pounds per square inch and the ability to superheat the steam to 850 degrees F became the norm.

36. The key to meeting this high horsepower demand was the development by the Navy of much high pressure, superheated steam propulsion plants. With the increased pressures came greatly increased temperatures and thus the need for much improved insulation technologies, both for plant efficiency and for operator comfort and safety. These "high power density" propulsion plants increased the operating temperatures of machinery and piping, and

they created a need for greatly improved thermal insulating and lagging materials. The Navy maintained significant expertise in the important areas of heat transfer and insulation. As a consequence, the thermal insulation needs associated with various equipment and systems was a significant issue in the design of Navy vessels from a number of perspectives. Thermal insulation served a number of important functions, as set forth, for example, by the 1947 version of the Navy's BUSHIPS Manual, a technical reference for Navy engineers, where Chapter 39 was devoted entirely to "Thermal Insulation":

39-2. REASONS FOR INSULATING

(l) In every power plant there is a heat loss from all heated surfaces and a heat f1ow to all cooled surfaces. Heat f10w may occur in three ways; by conduction, by convection, and by radiation.

(2) Conduction is the heat f10w from one part of a body to another part of the same body, or from one body to another with which it is in physical contact, without displacement of the particles of the body. This manner of heat f10w is most important in insulation as it is the low conduction which results in the greatest temperature differential between a hot insulated surface and the atmosphere (as in steam piping insulation), or the relatively warm atmosphere and a cold surface (as in refrigerating plant insulation). Heat transfer from insulated pipes or large blanketed or cemented surfaces (turbines, evaporators, etc.) to the outer surface of their lagging is included in this mode. Conduction is associated with solids and comparison of materials in this respect is measured by a factor called the "thermal conductivity" which expresses rate of conductivity in British thermal units (B.t.u.) per inch of thickness per hour per square foot of area per degree Fahrenheit temperature differential.

(3) Convection is the transfer of heat from one point to another within a fluid, gas or liquid, by circulating or mixing of one portion of the fluid with another. These currents are produced by warm fluid being displaced by heavier cold fluid. It is of interest to note that convection reduces the effectiveness of air space insulation unless such space is very small.

(4) Radiation is the method of heat transfer by which a hot body gives off energy in the form of radiant heat which is emitted in all directions. Radiant heat, like light, travels in straight lines and with the speed of light. The surface condition greatly affects the ability of a body to radiate heat. Dull, dark, rough finished surfaces are the best radiators. Conversely, bright, shiny, smooth surfaces are good heat reflectors.

> (5) In order to minimize the transfer of heat from or to a body or surface which is hotter or colder, respectively, than the surrounding atmosphere, thermal insulation is applied. This thermal insulation is a material or materials of low thermal conductivity. (See par. 39-2 (2).) While increasing the economy of the plant, thermal insulation also reduces the quantity of air necessary for ventilating and cooling requirements and prevents injury of personnel due to burns from contact with hot parts of apparatus. It also insures more uniform heat distribution within equipment. Another function of thermal insulation is to prevent "sweating" of cold surfaces on which atmospheric moisture condenses thus causing undesirable dripping as well as accelerated corrosion of the metal. Insulation must be sufficiently effective to reduce heat losses and lower surface temperatures to a degree which will permit habitable conditions in a specific space or compartment.

(Exhibit B, 39-2).

37. Due to the importance of heat transfer and insulation in Navy propulsion plants and aboard Navy vessels more generally, the Navy maintained significant expertise in these areas. The BUSHIPS manual and other documents issued and continuously updated by the Navy contained detailed instructions for the insulation by Navy shipyards or private contractors of various systems and equipment, including, primarily, the miles of piping associated with thermal systems aboard vessels. The Navy's specifications provided detailed instructions as to the specific insulating materials to be used, and also as to the amounts of those materials and the manner in which they were to be applied.

38. 38. A 1946 article entitled "A Health Survey of Pipe Covering Operations in Constructing Naval Vessels" summarized the extent of and reasons for the Navy's use of asbestos-containing insulation during World War II:

> The chief reasons for the wide use of amosite felt and pipe covering in naval work are its low thermal conductivity, light weight, strength, and refractoriness. When the felt and pipe cover were first developed, we were still building vessels under the Washington Treaty of Limitations in Tonnage, and every pound saved meant that much more armor, guns or ammunition for a given displacement, to say nothing of more economic operation for the weight involved in insulation.
>
> Amosite pipe covering weighs about 14 pounds per cubic foot, with a temperature limit of 750 degrees F. as compared to magnesia with a weight of 16 pounds per cubic foot[....]

> The development of amosite felt started in 1934 when a need existed to secure a thermal insulation lighter in weight and thermally more efficient than the materials (blocks and cement or asbestos blankets) which were then being used in destroyer turbines.... Originally amosite was used only for turbine insulation, but it proved so satisfactory that its field of application enlarged to include insulation of valves, fittings, flanges, etc. From the initial destroyer, it has been used on almost all the destroyers built since that time and on all other combat vessels built since before the War.
>
> Pipe covering was a later development in late 1935 and early 1936. Due to the manufacturing problems involved, it took a longer time to evolve into a satisfactory shape, and its first use on naval vessels was in 1937. Since that time its use has spread markedly and it was used on the great majority of naval combat vessels built during World War II.

(Exhibit C, p. 9).

39. The Navy's dictation of the methods and materials for insulation of thermal systems took various forms. As noted above, these included serial iterations of the BUSHIPS Manual's Chapter 39 on "Thermal Insulation." See Exhibits B (1947) and D (1959). The Navy also prepared and imposed upon Navy design engineers General Specifications for Machinery for Vessels of the United States Navy. Those specifications included an entire section - Section S39 - governing "Thermal Insulation for Machinery and Piping." The 1951 version of this document is attached as Exhibit E. Beginning in 1962, the Navy began issuing a Military Standard intended "to amplify the general requirements for insulation of piping, machinery, uptakes, and mechanical equipment covered in the General Specifications for Ships of the U.S. Navy or in ships specifications. (Exhibit F).

40. The Navy and/or its design agents prepared for the builders of Navy ships detailed drawings and plans showing the precise methods and materials for insulation of various systems and equipment. Those documents - referred to as "Insulation and Lagging Schedules" - implemented the overall requirements of the General Specifications and they provided the actual instructions to the personnel applying insulation as part of an integrated system of temperature control and energy conservation consistent with the Navy's needs in the operation of its ships. These plans are referred to as "Insulation and Lagging Schedules." They were typically

developed for each class of warship. Examples of such plans for the *USS Fletcher* and *USS Sumner/Gearing* class destroyers and the *USS Essex* class aircraft carriers are attached as Exhibits G, H and I. The Insulation and Lagging Schedules included details on the materials to be used, the thickness, installation procedures, and finishing details for tens or even hundreds of tons of thermal insulation materials to be applied by Navy and private shipyards. Once the Navy selected a construction shipyard, that shipyard was required to comply strictly with all Navy specifications, plans and drawings in the application of insulation and lagging to systems and equipment aboard Navy vessels.

41. As the attached documents demonstrate, throughout the World War II and post-World War II era, the vast majority of thermal insulating materials used aboard Navy vessels contained asbestos. Asbestos-containing materials offered many advantages over previous or alternative materials in meeting these needs. They were relatively light compared with previous materials, had better insulating properties, did not require excessive thicknesses in application, were more durable and were resistant dissolving in or absorbing salt water. The materials also served as fire protection in an environment in which fires were an ever-present danger.

42. Thus, the use of asbestos in thermal insulation allowed the Navy to design and field propulsion systems that met the demanding war fighting requirements of World War II and later. The importance of asbestos to Navy warships is attested to by the fact that it was assigned a high priority in the U.S. government's critical materials allocation process. Asbestos was in short supply during World War II, and its use was controlled through the War Production Board process. A very large percentage of asbestos was allocated to the needs of the Navy and U.S. Maritime Commission for use in insulation for ship construction.

43. The Navy's demands for asbestos-containing insulation were extraordinary. For example, the Insulation and Lagging schedules for destroyers of the Navy's *Sumner* and *Gearing* classes - relatively small vessels of which the Navy constructed approximately 200 during World War II - specified nearly 24 tons of asbestos containing thermal insulation be installed. A 1979

Department of the Navy letter (Exhibit J) recites the following estimates of the quantities of thermal insulation aboard different types of Navy vessels of the 1950s and 1960s:

Destroyer – DD	87,634lbs
Guided Missile Cruiser – CGN	123,770lbs
Submarine – SSN	62,465lbs
Replenishment Oiler – AOR	78,515lbs
Large Harbor Tug – YTB	6,858lbs

Larger vessels, such as aircraft carriers and battleships, required multiples of those amounts. Taken as a whole, in both new construction and overhaul, the Navy applied thousands of tons of asbestos materials aboard its vessels from the 1930s through the 1970s.

44. Due to the complexities of the ship design and construction process, and the global nature of the Navy's approach to selection and procurement of insulation and lagging materials, manufacturers of components were not consulted by the Navy with respect to insulation of their equipment. Moreover, they had no control over the types and quantities of insulation products to be used in conjunction with their equipment, nor could they even be certain whether or not any insulation would, in fact, be applied to their equipment due to the variety of circumstances and potential uses of the original equipment once aboard a Navy vessel.

45. Above and beyond the tens or hundreds of tons of thermal insulation used, other asbestos materials were ubiquitous aboard Navy vessels pursuant to Navy specifications and requirements. These materials included electrical insulating materials, flooring, refractories and sealing materials.

Navy Shipboard Documentation

46. Navy warships are sophisticated "mobile communities" outfitted with a vast array of complex equipment and manned by a crew of operators comprised of brand new recruits with no experience to seasoned senior technical professionals. In order to ensure effective, efficient and safe operation of its warships, the Navy, since at least World War II, has developed and

maintained extensive documentation for each ship class and individual ship. This extensive "library" of documentation consists of different major categories of subjects such as Organizational Regulations and Policy, Tactical, Technical, Administration, Logistics, and Training to name just a few. The intended audience and purpose of a document differs amongst categories and documents within those categories. Some documentation contains information relevant to the entire crew or ship while other documents address more focused subjects such as a ship department, a specific technical rating or an individual piece of equipment. Understanding the specific Navy objectives of different categories of documentation is helpful in understanding the required content and level of detail that the Navy specified to be included. Of particular relevance to shipboard operators of equipment are the categories of Training and Technical documentation.

Navy Shipboard Training Documentation

47. Shipboard training of Navy personnel consists of both individual and team training and each category includes both technical and non-technical requirements. The Navy defines individual training as any training, including in-rate training, which improves a member's usefulness to his unit. Team training is defined as the training of groups of officers and enlisted members to work effectively together as teams in the engineering spaces, on the bridge, in damage control parties and similar team efforts. Technical requirements (sometimes referred to as Occupational Standards) include the specific knowledge expected of an individual in his or her specialty, rate and rating. Non-technical requirements (sometimes referred to as Naval Standards) include subjects such as general naval knowledge of discipline, Navy Regulations, Uniform Regulations, first aid, shipboard safety, and similar all-hands subjects.

48. Training documentation in support of individual and team, technical and non-technical training was developed under the directives of the Chief of Naval Operations and the Chief of Naval Personnel. Examples of individual technical training documentation are the various Naval Personnel (NAVPERS) rate training manuals such as Machinist's Mate 3&2 and

Boilerman 3&2 and similar manuals for all ratings. Examples of individual non-technical training documentation are the Military Requirements for Petty Officers 3&2 and General First Aid Manual. Damage Control and Engineering Casualty Control Exercise Drill outlines are examples of Navy-developed team training documentation.

49. Training documentation, both technical and non-technical, was developed by the Navy with specific focus on the skills, level of experience, education and advancement requirements of the individuals and groups for which it was developed. It was typically developed with content applicable to all Navy members of that group. Thus, technical rate training manuals included general information about equipment and systems as opposed to focusing on any specific make or model. Non-technical general training documentation included information and examples that were relevant to all Navy personnel whether stationed afloat or ashore. The ultimate use of Navy training documentation was, and is, to assist the Navy members to become as proficient as possible both in their rates and specific skills and as Navy leaders and managers.

Navy Shipboard Technical Documentation

50. Unlike Navy shipboard training documentation that is focused on training individuals and teams, Navy shipboard technical documentation is developed and provided as reference material that can be consulted if and when required in the operation, maintenance and repair of equipment and systems. Navy shipboard technical documentation includes various categories from high level Navy technical policy documents such as the Bureau of Ships Technical Manual to equipment specific documents such as BUSHIPS drawings/blue prints, system schematics, and troubleshooting manuals.

51. The Bureau of Ships Technical Manual (BSTM) was a multi-chapter manual that documented the Bureau of Ships-level technical policy and procedures developed and used by BUSHIPS engineering and technical organizations in the design and life-cycle support of Navy ships and installed equipment.

52. Equipment specific technical documents such as BUSHIPS drawings and systems schematics contain information of sufficient detail to allow maintenance and repair of shipboard equipment by ship's force personnel while operating at sea and in remote areas where outside assistance is not available.

53. The Navy typically developed equipment operational guidance manuals for more complex equipment and systems. Typically, the Navy required these "instructional manuals" for equipment that required operator involvement in start-up, operation, and shutdown. Equipment that did not require operational steps, such as globe and gate valves, and equipment that operated "passively", without operator involvement, such as steam traps and check valves, would typically not require a "technical or instructional manual". Examples include equipment level Technical Manuals (sometimes called Instruction Books) and system-level manuals such as the DD-445/692 Classes Main Propulsion Plant Operations Manual.

54. The Navy identified a need and developed standards for equipment Technical Manuals. Unlike a civilian "owner's manual" for an appliance or consumer purchased equipment that was developed by the manufacturer with content that might be considered "helpful" to a broad range of potential customers or users, Navy equipment Technical Manuals were developed by the Navy to detailed technical content and format requirements for use by a known audience of Navy-trained shipboard technicians. The purpose of these documents was to provide information specific to the equipment, with a focus on its operation, and avoidance of injuries or accidents that might occur during operation.

55. The purpose of Navy shipboard technical documentation was to provide technical information that could be referenced and understood by the ship's operators if and when needed. Although certainly available to augment Navy training documentation if desired, the shipboard

technical documentation was not readily accessible by all personnel, and was not part of the training documentation.

Documentation Regarding Warnings

56. As described above, the content of Navy training documentation focuses on Navy-wide groups of users whereas Navy technical reference documentation is equipment and system specific. Thus, Navy decisions concerning which category of document to include desired warnings and cautions were dependent on the nature of such warnings and caution statements. Warnings and cautions concerning Navy-wide/all-hands subjects such as general shipboard safety, safe driving awareness, hearing loss prevention and later asbestos health warnings were included in readily available and broadly used training documents, some in technical documentation such as Navy rate training manuals, and some in non-technical documentation such as General Military Training syllabuses. Warnings and cautions concerning immediate hazards unique to the operation and maintenance of specific equipment were included in equipment and system specific technical documents such as equipment technical manuals and system level operating manuals which were aimed and available to only limited audiences of personnel directly involved in work on the specific systems or equipment covered by the manuals. Such manuals were not, therefore, appropriate locations for warnings and cautions relating to general or widespread shipboard health issues.

Written Materials Regarding Equipment Supplied to the Navy

57. Technical specifications referenced in the procurement documents for components such as valves and pumps have, since at least the 1940s, included detailed requirements regarding all written materials supplied with valves and pumps. Manufacturers were required to supply drawings and plans, and at times draft technical manuals for equipment. The applicable specifications included strict instructions regarding the labeling of and packaging of the components themselves, and for all technical documentation that was procured with them.

58. To achieve its objective of ensuring that, in form and content, the marking on equipment filled the specific informational role, for the specific Navy audience and environment, the Navy developed precise specifications as to the nature of any markings, communication or directions affixed to or made a part of any equipment supplied by OEMs for ultimate use aboard Navy ships. OEMs would not have been permitted, under the specifications, associated regulations and procedures, nor under the actual practice as it evolved in the field, to vary or to deviate in any respect from the Navy specifications in supplying equipment, including affixing any type of warning or caution statement to equipment intended for installation in a Navy ship, beyond those specifically required by the Navy without prior discussion and express approval by the Navy.

59. The Navy likewise had precise specifications as to the nature of written materials to be delivered with equipment supplied by OEMs to the Navy. This written material included a variety of formats such as design drawings, system schematics as well as operator reference materials to assist the equipment operators in operating, servicing and maintaining such equipment and to assist the Navy training establishment to develop instructional materials and courses. Through specifications, the Navy required that certain equipment be supplied with a defined number of copies of one or more instruction books or technical manuals. The Navy typically developed these technical manuals by including development of a draft manual as part of equipment procurement contracts. The draft manuals were required to be submitted to the Navy for detailed review and feedback. Once the draft manuals were found to be acceptable to the Navy, a BUSHIPS number was assigned and the manual became an official BUSHIPS document the contents of which were controlled by the Navy. The term "manufacturer's instruction books" that is found in many Navy rate training manuals refers to these Navy developed and approved technical manuals.

60. Navy personnel or those of the Navy's Design Agents participated intimately in the preparation and review of these instruction books and technical manuals in a standardized format used by the Navy. These manuals included safety information to the extent – and only to

the extent – directed by the Navy. Manufacturers of components and equipment were not permitted, under the specifications, associated regulations and procedures, nor under the actual practice as it evolved in the field, to include any type of warning or caution statement in instruction books or technical manuals, beyond those required and approved by the Navy without prior discussion and approval by the Navy. The Navy dictated and, itself or through its Design Agents, reviewed and approved the contents of all technical manuals, including any cautionary language or emphasis. The Navy approached this process for review and approval of technical manuals in an exacting manner. It often created lengthy memoranda detailing word-by-word line edits to the content of technical manuals submitted for approval, including the wording of instructional material and warnings. Examples of such correspondence are attached hereto as Exhibit K. Review of and comment upon instructional materials by the Navy's Design Agents was similarly detailed.

61. The reasons for the Navy's detailed control over and review and approval of all written communication regarding equipment it procured was to ensure consistency of that information with the overall goals and priorities of the Navy in its operations. The Navy employed millions of uniformed and civilian personnel aboard thousands of vessels and at hundreds of land-based facilities around the world. The information provided with regard to equipment had to be consistent with the Navy's overall evaluation of the appropriate types and level of information its personnel required to efficiently perform their job responsibilities under a variety of circumstances. In addition, written communications regarding work practices, including safety precautions and equipment, had to be coordinated with the training of Navy personnel, the physical circumstances in which they performed their work, and the tools, protective devices and equipment and other materials available aboard Navy vessels and at Navy installations.

62. Uniformity and standardization of any communication, particularly safety information, are critical to the operation of the Navy and Navy ships. The Navy could simply not operate safely and effectively if personnel were trained differently, or were provided with

inconsistent information received from different manufacturers, each left to its own discretion in trying to anticipate the Navy's needs. If every equipment, structural steel and pipe manufacturer were allowed to decide on the need for, and provide its own safety and health warnings (including those concerning asbestos insulation that might be used on or around its product), inconsistent warnings would certainly have resulted. If each were to warn about all the possible substances that might be used on or around its equipment, sailors would quickly become inundated with inconsistent information on a myriad of substances. Therefore, the Navy's detailed specification of what warnings were required, both on equipment and in technical documentation, was logical and necessary.

63. Asbestos-associated health issues, and the insulation materials with which the Navy associated those issues, were ubiquitous in Navy environments. Tens of tons of asbestos-containing insulation were present in mechanical and other spaces aboard Navy vessels. Consistent with its objective to ensure that all documentation to which its personnel were exposed be thoroughly consistent with its overall training and procedures, the Navy would not have permitted equipment suppliers to place asbestos-related warnings on packaging or containers for valves and pumps or related parts or items supplied during the 1940s, 1950s, or 1960s. Similarly, the Navy would not have permitted equipment suppliers to place asbestos-related warnings in any literature or documentations supplied with valves or pumps for Navy ships during the 1940s, 1950s and 1960s.

64. In this regard, it is useful to consider the Bureau of Ships Technical Manual. This manual, prepared by the Navy and updated periodically, was intended to provide guidance and information to Navy personnel on various matters. The Manual contained specific chapters covering numerous topics.

65. A review of examples of Chapter 47 relating to pumps and Chapter 95 relating to gaskets and packing reveals that even when drafting its own manuals governing activities widely known to involve asbestos, the Navy nowhere included any cautionary language regarding – or even any mention of – any potential hazards relating to asbestos. In addition, neither Chapter 39

of the BUSHIPS Manual relating to insulation nor Chapter 48 covering piping (and valves) likewise contained reference to such hazards during the 1940s, 1950 and 1960s. Similarly, the Navy's system-level manuals of the type described above likely did not, even where they pertained to propulsion or other systems on which the Navy required shipbuilders and Navy personnel to install large amounts of asbestos insulation, contain asbestos-related cautions to Navy personnel.

66. The absence of asbestos-related cautionary language in the Navy's own manuals for equipment or for asbestos-containing materials is consistent with the notion that the Navy did not accept, and did not permit, asbestos-related warnings in technical manuals relating to individual pieces of machinery or equipment, and is fully consistent with my experience that such warnings were not neither sought nor welcome from manufacturers of such items.

67. Based upon my knowledge of and experience in the design, inspection and procurement of equipment for use on Navy vessels, the Navy would not have permitted equipment suppliers to place asbestos-related warnings on packaging or containers for valves, pumps or related parts or items supplied during the 1940s, 1950s, or 1960s. Similarly, it is also my opinion that the Navy would not have permitted equipment suppliers to place asbestos-related warnings in any literature or documentations supplied with valves or pumps for Navy ships in the 1940s, 1950s and 1960s.

68. The Navy maintained precise Navy Specifications and later Military Specifications that detailed all aspects of label plates that were required on equipment. The Navy and military specifications for identification plates included materials to be used, method of attachment, size of plate, information and format of information required, and many other details to ensure standardization of such plates. The content and format of information that was to appear on those plates was required to be submitted to the Navy for approval. MIL-I-15024 and MIL-I-15024B are examples of such precise military specifications for identification plates, and are attached as Exhibits L and M.

69. I have reviewed and am familiar with the BUSHIPS and later MILSPEC standards for technical manuals, including BUSHIPS General Specifications for Machinery Subsection S-I-1 of 1941 (Exhibit N); and later MILSPECS including MIL-M-15071 (Exhibit O), MIL-M-15071A (Exhibit P), MIL-M-15071B (Exhibit Q), MIL-M-15071C (Exhibit R), and MIL-M-15071D (Exhibit S). These MILSPECs confirm that the Navy was very specific in detailing what information would be included in these equipment technical manuals. The wording of these documents is consistent with my overall opinion that the Navy intended technical manual text to address operating procedures and related equipment and personnel safety issues specifically associated with the particular equipment to which the technical manual related, rather than to generic occupational health issues. In MIL-M-15071D, adopted in 1961, the Navy included the terms Note, Caution and Warning as possible text in technical manuals. In the section of that MILSPEC that details the requirements for Text to be used, the MILSPEC includes what is termed "Emphasis" language to be used when necessary. It further defines three emphasis terms to be used: "Note", "Caution" and "Warning". The MILSPEC clearly states that these terms will be used sparingly and as adjuncts to text that details operating procedures for the equipment. Thus, these terms could only be included in a technical manual to emphasize specific operating instructions that, if not properly followed, would result in either damage to the equipment or related injury to the operator. The term "Caution" is specified to be used to emphasize an operating procedure that must be followed to prevent damage to the equipment, and the term "Warning" is specified to be used to emphasize a procedure that must be followed to prevent personal injury while operating the equipment. Like both earlier and later versions of the 15071 series, MIL-M-15071D required that all manuals be submitted in draft to the Navy for review and approval prior to finalization and delivery with equipment.

70. It is also my personal experience that the terms "Note", "Caution" and "Warning", when used in Navy equipment technical manuals refer specifically to safe operating and maintenance procedures and not to any more generic health related issues.

MIL-STD-129 - Purpose and Utilization in Navy Procurement Actions

71. MIL-STD-129, titled "Marking for Shipment and Storage", is a Department of Defense level Military Standard that provides guidance for the uniform marking of military supplies and equipment for shipment and storage. It was first issued in August 1951 and consolidated and superseded previous requirements that had been issued by the separate military services. It has been updated several times since then. Since it was first issued, MIL-STD-129 has been included as one of many higher level referenced documents in many Military Specifications. The Military Specifications typically state that those higher level referenced documents form a part of the Military Specification to the extent described in the Military Specification. The Military Specifications are more detailed in their content and requirements than Military Standards and include a wide range of detailed requirements for equipment and materials. Navy procurement contracts utilize numerous applicable Military Specifications to detail the technical requirements that must be met in complying with the contract.

72. Military Specification MIL-P-16789B(SHIPS) of 9 November 1962, titled "Military Specification, Preservation, Packaging, Packing and Marking of Pumps, General, and Associated Repair Parts", is one example of a Military Specification that references MIL-STD-129. Paragraph 2.1 of MIL-P-16789B states that MIL-STD-129 and the other listed Federal and Military Specifications and Standards form a part of MIL-P-16789B to the extent specified therein. Paragraph 3.4, titled "Marking", stated that in addition to any special marking required by the contract or order, interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129. In this way, the requirements defined in MIL-STD-129 are invoked in the contract without having to repeat them. MIL-STD-129 defines two types of interior packages:

- Unit package is the first tie, wrap, or container applied to a single item or a multiple thereof, or a group of items preserved or unpreserved, which involves a complete or identified package.

- Intermediate package is an interior container which contains two or more unit packages.

Although this example applies specifically to a pump MILSPEC, MIL-STD-129 likewise was an included reference in other MILSPECs for valves, turbines and other types of equipment.

73. MIL-STD-129 (including version 129C) is detailed and complete in specifying all aspects of marking requirements for shipment and storage. Specific requirements are imposed with respect to cautionary labels required by the government and, by omission, those not permitted on packaging or containers. Examples of required cautionary labels include radioactive and magnetic materials. Compliance with these requirements is mandatory. Deviations cannot be made without approval and specific instructions from a cognizant military authority. Paragraph 4.2.1 of MIL-STD-129C states, "No markings, other than those specified in this standard, or authorized by the cognizant activity concerned, or those required by regulation or statute, shall be placed on any container, except as permitted in 4.2.1.1." (Paragraph 4.2.1.1 addresses advertising and case marking and does not relate to warnings, cautions or instructions.) Thus, deviations in required markings, including fewer markings, additional markings, or markings not exactly in accordance with the standard all required prior specific instructions from the cognizant military authority.

74. Section 5.2.2.4 of MIL-STD-129C imposes a requirement that packages or containers of "hazardous chemicals" must "have affixed thereto such warning labels as may be required by the Manufacturing Chemists Association (MCA) Manual L-1 "A Guide for Preparation of Warning Labels for Hazardous Chemicals", or by appropriate Department of Defense instructions and Military specifications and standards as published which shall take precedence." Neither the referenced Manufacturing Chemists Association document, nor Section 5.2.2.4 has any applicability to equipment such as valves and pumps, to technical manuals relating to such items, or to asbestos-containing gaskets or packing that might have been supplied with such equipment.

75. Both MIL-STD-129 and the referenced MCA Manual L-1 by their terms apply to external marking of the shipping/storage containers and interior packages as defined above of military supplies and equipment. In the case of equipment such as valves and pumps procured by the Navy for use in the construction or repair of ships, there are no interior packages as defined in MIL-STD-129. The exterior shipping container would typically be opened and discarded at the receiving shipyard or repair activity before the equipment or valve was taken aboard the ship. Thus, the MIL-STD-129 shipping markings would not be seen by the mechanics installing the equipment and certainly would have never been seen by the operators and maintainers of the equipment once it was aboard the ship.

76. I have reviewed the Secretary of the Navy Instruction of 24 September 1956 and three enclosures (labeled SECNAV 6260.3 and hand changed to 5100.8) titled Uniform Labeling Program for hazardous industrial chemicals and materials. In my opinion that instruction when issued and since was not intended to and never did apply to the labeling of equipment for naval ships manufactured in response to Navy procurement requests and in compliance with applicable Navy and MILSPEC technical reference documents.

77. This particular SECNAV Instruction, as clearly stated in paragraphs 1 and 2, addresses standardized labeling of the containers that are used for hazardous chemical products that will ultimately be used by personnel at the shop, office or unit level. Furthermore, paragraph 3 states that the instruction is issued in response to "the rapid development of new chemical products and the introduction of new chemical processes."

78. SECNAV Instruction 5100.8 also was not intended and did not apply to the labeling of equipment for naval ships manufactured in response to Navy procurement requests and in compliance with applicable Navy and MILSPEC technical reference documents. The SECNAV Instruction for labeling the containers of chemical products for use by personnel has no relevance to the manufacture, packaging and labeling of equipment such as valves and pumps procured by the Navy from industry. This equipment typically was packaged and shipped either to a shipyard for use in building or modernizing a ship or to the Naval Supply Systems

Command as repair parts. They are not shipped to end users such as those described in the SECNAV Instruction 5100.8 mentioned above.

79. Also included in the SECNAV Instruction 5100.8 discussed above were specific implementation actions to be taken by various Navy organizations including the technical bureaus including the Bureau of Ships (BUSHIPS). Those bureaus were required to implement the instruction and to undertake the classification and labeling of chemical and hazardous materials as defined in SECNAV Instruction 5100.8. Yet in review of numerous MILSPECS and other technical reference documents for equipment such as valves and pumps procured and installed on naval ships in the late 1950s and subsequent, I have never seen this SECNAV instruction referenced nor have I seen the classification of such valves and pumps as hazardous equipment as defined in the instruction. This is further evidence that this instruction does not apply to equipment such as valves and pumps.

Navy Organization

80. Consistent with the sweeping scope of its mission and responsibilities, the Navy is comprised of many different organizations, each of which is specialized in focus, talent and experience. These organizations work together in accomplishing the very complex and unique sequential efforts from the defining naval war fighting requirements, designing ships and weapon systems that will meet these requirements, and contracting with industry and other government agencies to procure the vast array of required equipment and materials and to construct and test warships. This diverse Navy organization can be described in four major groupings:

-- Secretary of the Navy (SECNAV) and the Chief of Naval Operations (CNO) headquarters staffs (CNO staff is referred to as OPNAV)

-- Operational Fleets

-- Technical Bureaus (now called Systems Commands)

-- Staff Corps (Medical, Dental, Legal, etc.)

SECNAV and CNO Staffs

81. The staffs of Secretary of the Navy (SECNAV) and the Chief of Naval Operations (CNO) are involved in the analysis of national naval war fighting needs, and the development of specific war fighting requirements that must be met. At a top level for warships, these requirements include such things as the types and numbers of ships needed; the capabilities for these ships such as speed, weapons to be installed; types and numbers of aircraft to be embarked; the range and duration at which these ships must be able to operate independently at sea without replenishment; and the reliability of systems that must be guaranteed in order for the Navy to meets its war fighting mission. These staffs are manned by a combination of experienced uniformed Navy personnel with extensive Fleet experience and career civil servants.

Operational Fleets

82. The Operational Fleets are the Navy's war fighters who control and operate the various ships, aircraft, and other equipment in the Navy and Marine Corps. There are several numbered Fleets *(e.g.,* Sixth Fleet, Seventh Fleet) with regional geographic responsibilities around the world. These Operational Fleets have always worked closely with the headquarters staffs in the development of naval warship required capabilities.

Technical Bureaus

83. The Bureau System was established in 1842 to provide the Navy with necessary technical and management control. By the early 1940s, there were six bureaus:

-- Bureau of Naval Yards and Docks

-- Bureau of Ships (BUSHIPS)

-- Bureau of Supplies and Accounts (BUSANDA)

-- Bureau of Ordnance and Hydrography

-- Bureau of Medicine and Surgery

-- Bureau of Aeronautics

84. In the 1950s, a Bureau of Weapons (BUWEPS) was formed by merging the Bureau of Ordnance and the Bureau of Aeronautics. In the 1960s the bureau system evolved several times into what are now called the Systems Commands where BUWEPS was divided into the Naval Air Systems Command and Naval Ordnance Command (NAVORD), and BUSHIPS was divided into the Naval Ship Systems Command (NAVSHIPS) and the Naval Electronics Systems Command. In 1975, another reorganization took place in which NAVSHIPS and NAVORD became the Naval Sea Systems Command (NAVSEA). During this organizational evolution the Bureau of Supplies and Accounts (BUSANDA) became the Naval Supply Systems Command.

Navy Staff Corps

85. The various staff corps of the Navy are comprised of professionals such as doctors, dentists, and lawyers who support all aspects of the Navy in their respective specialties.

86. The Bureau of Medicine & Surgery (BUMED) has always had a very significant role in both the design and operation of Navy warships, in addition to its fundamental role in the overall health and well-being of Navy personnel. All ships have medical facilities integrated into the design, both for normal medical support of the large crews, and for treatment of battle injuries. Small ships such as destroyers have a modest infirmary space and other spaces that can be converted for medical use while at battle stations. Larger ships have much greater medical capability, with aircraft carriers being fully equipped with several operating rooms for surgery and large hospital wards for sick and wounded personnel.

87. BUMED also plays a very significant role in the operation of Navy ships. BUMED establishes the medical policies and procedures, both preventive and curative, which are utilized on all Navy warships. Additionally, the crew of each warship includes medical personnel who are involved in preventive medicine, crew training, health inspections, and treatment of ailments and injuries. Small ships such as destroyers typically have one highly

trained enlisted hospital corpsman assigned, and large ships have both physicians and hospital corpsmen. Aircraft carriers have numerous medical doctors and surgeons with various specialties.

Responsibilities in Warship Design and Construction

88. Responsibilities for the various functions associated with warship design and construction in from the World War II period to the 1970s were as follows:

SECNAV and OPNAV Staffs

89. Working closely with the Operational Fleets and Bureaus, these staffs had the responsibility for defining naval war fighting requirements, developing concepts of operations and ship concepts, and requesting congressional authority and funding to build war ships.

BUSHIPS

90. The Bureau of Ships (BUSHIPS) was comprised of a broad assortment of engineers and technical personnel, and was responsible for all technical aspects of Navy warships. Included were the preliminary designs of ships, the detailed design of ships, subsystems and equipment, and development of the contract design package. BUSHIPS, aided by BUSANDA, had the responsibility to develop the contract design package and the myriad invitation for bids required to actually procure and construct the ships. All U.S. Naval Shipyards were under the direct command of BUSHIPS, as were the resident Supervisors of Shipbuilding who performed the same government supervisory functions at civilian shipyards. Thus, BUSHIPS was responsible for both the new construction and future repair and overhaul of ships at both naval and private shipyards. BUSHIPS and BUSANDA each had on-site Navy inspectors

at various vendors' plants that were responsible for verifying that the vendor complied exactly with all provisions of that vendor's procurement contracts. BUSHIPS was also responsible for the design development of equipment repair and maintenance standards and procedures, and for the development of Navy Specs/MILSPECs that related to ships and ship equipment.

Other Technical Organizations

91. Warships are equipped with many different weapon systems, aviation capabilities, and the accompanying electronic equipment. Therefore, many other Navy and national technical organizations provided support to BUSHIPS in all phases of design and construction. Principal supporting organizations included the Bureau of Ordnance, the Bureau of Aeronautics, and the Naval Electronics Command. Also key in the development and testing of warship propulsion equipment and systems were the National Boiler Test Lab and the Naval Ship System Engineering Station.

BUSANDA

92. The Bureau of Supplies and Accounts (BUSANDA) was comprised of a variety of professionals with specialties in areas such as government contracting, logistics planning, financial and business management, warehousing and parts distribution management, etc. BUSANDA, in addition to on-site and continuous support of BUSHIPS and other technical bureaus, also provided all Supply Corps officers to the Operational Fleet. The Supply Corps officers were assigned to both ships and Fleet staffs and were responsible for planning and managing all shipboard messing, berthing and spare parts management. BUSANDA was responsible for maintaining and managing the vast inventory of spare parts, consumables, documentation, and replacement equipment for the Navy.

Signed on the 7th day of May 2012 at Great Falls, Virginia.

David P. Sargent, Jr.

Exhibit A

15 January 1938 45V19(INT)

BUREAU OF ENGINEERING SPECIFICATION

VALVES, HIGH PRESSURE, GLOBE AND ANGLE, FORGED STEEL, WELDING ENDS,

SIZES, 1/4-INCH TO 1-INCH INCLUSIVE

600 Lbs. W.S.P. and 850°F. Maximum Temperature

(Shipboard Use)

A. APPLICABLE SPECIFICATIONS AND DRAWINGS.

A-1. The following specifications, of the issue in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies.

NAVY DEPARTMENT SPECIFICATIONS

General Specifications for Inspection of Material, together with Appendix II (Metals).
42N2 - Nameplates, Instruction plates, and other designating markings for electrical and mechanical equipment (shipboard use).
42S5 - Screws, machine.
43B11- Bolts, nuts, studs, and tap rivets (and material for same).
43B14 - Bolt studs, steel rods and nuts for service at temperatures up to 850°F.
45V18 - Valves, high pressure, globe and angle, steel (Shipboard use).
46A1 - Aluminum alloy, light castings.
46B6 - Brass, naval, rolled: bars, plates, etc.
46B10 - Brass, naval: castings.
46-I-8 - Iron, malleable: castings.
46M6 - Metal, gun: castings.
46M7 - Nickel-copper alloy, rolled.
46P1 - Plating, cadmium.
46R5 - Rods, welding, cobalt-chromium composition.
46S13 - Steel, corrosion-resisting; bars, rods and forgings (except for reforging)
46S33 - Steel castings, molybdenum alloy (for temperatures up to 850°F.).
46S34 - Steel forgings, molybdenum alloy (for temperatures up to 850°F.).
49S1 - Steel: castings.
49S2 - Steel: forgings for hulls, engines, ordnance.

BUREAU OF ENGINEERING SPECIFICATIONS

General Specifications for Machinery, Subsection S1-1.

A-2. The following Bureau of Engineering drawings, of the latest alteration in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies:

B-64 - Handwheels for valves.
B-100- Finish marks.
B-147- Seamless drawn steel tubing.
B-153- Standard application of annual contract packing.
3-S-530- Forged steel welding end fittings.

B. TYPE.

B-1. Valves covered by this specification shall be furnished in but one type.

C. MATERIAL AND WORKMANSHIP.

C-1. Departures from Referenced Specifications.- The use of materials differing from the referenced Navy Department specifications will be considered when it can be clearly demonstrated that an improvement in operating characteristics, or a saving in weight without sacrifice in reliability can be accomplished thereby, or that such substitutes do not preclude the subsequent use of Navy standard materials in effecting repairs or replacements necessitated by service wear. Specific approval shall be obtained where departures are made from the referenced specifications.

C-2. Materials.- All materials used in the construction of valves shall be as specified in Section E. Alternate materials will be considered in lieu of those specified but their use will only be permitted after the Bureau has been satisfied by test or other means that the proposed substitutes fully meet the service requirements.

C-3. Threaded Parts; Standard Bolts, Nuts and Machine Screws.- Bolts and nuts shall conform to F.D. Specs. 43E11 or 43E14, referred to in Section A, as applicable. All threaded parts shall be assembled with the use of a suitable high temperature thread lubricant satisfactory to the Bureau.

C-4. Workmanship.- All parts shall be free from flaws, burrs, and blemishes. The workmanship shall be first class in every respect.

D. GENERAL REQUIREMENTS.

D-1. (See Section E).

E. DETAIL REQUIREMENTS.

E-1. Plans.- Plans shall be furnished as required by the bureau concerned.

E-1a. Bureau of Engineering.

E-1a(1). The number, size, arrangement, title, form, etc., shall conform to the requirements of Subsection S1-1, referred to in Section A.

E-1a(2). The specific plans desired, except as provided by subparagraphs E-1a(3) and E-1a(4), shall include the following:

Type A.
Type B.
Type D.

E-1a(3). Type A drawings shall accompany bids, except when the bidder has filed with the Bureau approved drawings of the valves, in which case it will suffice to quote the Bureau file numbers of the drawings for identification that the valves have been approved by the Bureau and meet these specifications.

E-1a(4). Type B and Type D drawings will not be required provided the contractor has filed with the Bureau approved drawings of the valves.

E-2. The materials shall conform to the following:

(a) Body and bonnet.- Class A forged carbon-molybdenum steel (N.D. Specs.46S34).
(b) Bonnet bolt-studs and nuts.- Steel (N.D. Spec. 43B14).
(c) Bonnet yoke bushing.- Gun metal (N.D. Spec. 46M6).
(d) Bonnet gasket.- Soft steel or iron sheet; nickel-copper alloy sheet, (N.D. Spec. 46M7), dead soft annealed; or copper-nickel zinc sheet of approximately 64 percent copper, 30 percent nickel and 6 percent zinc. Brinell 80 or less for all.
(e) Disk.- Cast carbon-molybdenum steel, (N.D.Spec. 46S33) or forged carbon-molybdenum steel (N.D. Spec. 46S34); (see item g for seating face).
(f) Disk nut.- Forged steel, Class C (N.D. Spec. 49S2).
(g) Disk and seat, seating faces.- Cobalt-chromium composition (N.D. Spec.46R5).
(h) Flange bolt - studs and nuts.- (Bureau Standard Sheet B-174).
(i) Gland, stuffing box.- Class C cast of forged steel (electro-galvanized) (N.D. Spec. 49S1 or 49S2)
(j) Gland bolts.- Steel, Class B (N.D. Spec. 43B11), cadmium plated (N.D. Spec. 46P1); nuts - steel, Class C (N.D. Spec. 43B11), cadmium plated (N.D. Spec. 46P1); or Naval brass (N.D. Spec. 46B6).
(k) Handwheels.- See Bureau Standard Sheet B-64.
(ℓ) Lock washer for disk nut.- Corrosion-resisting steel, Grade 1, (N.D. Spec. 47S20).
(m) Set screws and split pins.- Steel.
(n) Stem bushing.- Special nickel-copper alloy, 52 to 56 percent nickel, 30.5 to 34 percent copper, 10.5 to 13 percent tin, 0.35 to 1 percent silicon, 0.30 to 0.75 percent manganese, 0.40 to 1 percent phosphorous and 1 to 2 percent iron. Minimum tensile strength 60,000 pounds per square inch. Brinell 190 to 235. Other materials satisfactory for the service will be given consideration.
(o) Stem for disk.- Forged corrosion-resisting steel, grade 7, (N.D. Spec.46S18)
(p) Stem nuts.- Naval brass (N.D. Spec. 46B6).
(q) Washer between end of rotating stem and disk.- Nitralloy or equivalent, at least 800 Brinell hardness.
(r) T-handles.- Naval brass (N.D. Spec. 46B10), or malleable iron (N.D. Spec. 46-I-8).

E-3. Valves shall be so designed as to insure positive tightness under severe service.

E-4. The bodies of all valves shall be so fitted that the valves may be easily ground in.

E-5. The characteristic dimensions of all valves shall be as given in Figure 1.

E-6. Bodies and bonnets shall be forged.

E-7. The unrestricted area through the seats, with the disk in the full open position, and through all body passages, shall be not less than that given in column "B" of the table shown on Figure 1.

E-8. Valves shall have bolted bonnets. The joint faces for bonnet flanges shall be male and female and shall have (f2) finish; see Bureau Standard Sheet B-100, referred to in Section A. The bonnets shall be secured by studs or bolt-studs.

E-9. Yokes shall be integral with the bonnets, but a design with separate yoke will be given consideration. The yoke shall be fitted with a bushing threaded to suit the stem.

E-10. Stems shall have outside Acme type of threads unless otherwise approved, and shall turn right-hand to close the valves.

E-11. Valve disks shall be of the plug type with swivel attachment to the stems and the seating area faced with cobalt-chromium composition not less than 3/32-inch thick for 1-inch and 3/4-inch valves, and 1/16-inch thick for valves 1/2-inch and smaller; the composition to be deposited by welding to insure positive bond between it and the disk. Disks shall be secured to the stems by nuts locked in place; other means for securing disks for 1/4-inch and 3/8-inch valves will be considered if the method is described in the bid. A hardened washer shall be inserted between the end of all stems and disks for valves 3/4-inch and larger to prevent galling.

E-12. Valve seats shall be integral with the bodies. The seating area shall be faced with cobalt-chromium composition in compliance with similar requirements for the disks; see paragraph E-11. The included seat angle shall be 30 to 60 degrees.

E-13. Stuffing boxes shall be of ample depth for at least six turns of packing, except 1/4-inch valves which shall have at least four turns. Stuffing boxes shall be arranged so that they can be packed when under pressure with the valve open. Valves shall be delivered with stuffing boxes suitably packed. The packing shall be as approved; see Bureau Standard Sheet B-153, referred to in Section A. Stuffing box glands shall be secured and adjusted by studs, and nuts.

E-14. Handwheels.- Handwheels shall conform to Bureau Standard Sheet B-64, referred to in Section A. The minimum diameters shall be as given in the table shown on Figure 1. All handwheels shall have the rims and the upper face of hubs finished and buffed and the spokes and unfinished portion of the hubs wire brushed, unless required to be finished and buffed all over. All handwheels shall be secured by means of a hexagonal nut threaded to the stem. T-handles may be used instead of handwheels for 1/4-inch and 3/8-inch valves.

E-15. Each valve shall have distinctly stamped, or equivalent, on one side of the body, the "size", "W.P.", "600", and in the case of globe valves, the position of the seat, for identification. The manufacturers trade mark may also appear on the body. When space does not permit this, the marking shall be as directed.

F. METHODS OF SAMPLING, INSPECTION AND TESTS.

F-1. Chemical and physical tests shall be made as required by the specifications covering the various materials used.

F-2. Five percent of the initial quantity of valves on order for any new design shall be selected by the Naval Inspector and tested to a steam pressure of 600 pounds per square inch gage, at a temperature of 850°F. Such test shall include tests for tightness on both sides of the disk, and tightness of the body. On subsequent cumulative orders, on the same manufacturer for valves of the same design a total of five percent of each size of valve so ordered shall be given the above steam test. This shall be interpreted to mean that of each one hundred valves of the same size and design ordered, the Inspector may select at his discretion five valves to be steam tested. Valves so selected may be taken from one order or from a multiplicity of orders totalling one hundred valves as desired, the number tested being a percentage of the total runs of valves and not a percentage of each individual order.

F-3. All valves shall be tested as follows:

(a) By hydrostatic pressure to at least 1500 pounds per square inch for strength and porosity with the disk open.
(b) By hydrostatic pressure to at least 750 pounds per square inch for tightness on seat with the disk closed by hand and without the use of a wrench or equivalent, the pressure shall be applied alternately on both sides of the disk with the side opposite the pressure open for inspection in each case.
(c) By air pressure to approximately 100 pounds per square inch for porosity and tightness on seat, procedure to be as outlined in (b) above.

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT.

G-1. Packing.- Unless otherwise specified, the subject commodity shall be delivered in substantial wooden crates or boxes, so constructed as to insure safe delivery by common or other carrier to the point of delivery. Not more than five valves shall be packed in a container. The valves shall be packed rigidly, or secured in the containers in such a manner as will prevent damage from shifting while being handled or transported. Sets of spare parts, if furnished, shall be packaged or bagged, and secured to the valve to which they belong.

G-2. Marking.- Unless otherwise specified, shipping containers shall be marked with the name of the material, the type, size, and the quantity contained therein as defined by the contract or order under which the shipment is made, the name of the contractor, and the number of the contract or order, and the net and gross weight.

H. NOTES.

H-1. Requisitions and contracts or orders should state the number of Type B and D drawings desired. See subparagraphs E-1a(3) and E-1a(4).

H-2. This specification supersedes Supplementary General Specification for Machinery, SGS(48)-155 formerly issued by the Bureau of Engineering, Navy Department, Washington, D.C.

H-3. Copies of Drawings and Specifications.

H-3a. Copies of Drawings.- Copies of Bureau of Engineering drawings may be obtained only upon application to the Bureau of Engineering, Navy Department, Washington, D.C. When requesting, refer to drawings by both title and number.

H-3b. Copies of Bureau of Engineering Specifications.- Copies of Bureau of Engineering specifications may be obtained only upon application to the Bureau of Engineering, Navy Department, Washington, D.C. When requesting, refer to specification by both title and number.

H-3c. Copies of Navy Department Specifications.- Copies of Navy Department specifications may be obtained upon application to the Bureau of Supplies and Accounts, Navy Department, Washington, D.C., except that naval activities should make application to the Commandant, Navy Yard, New York, N.Y. When requesting, refer to specification by both title and number.

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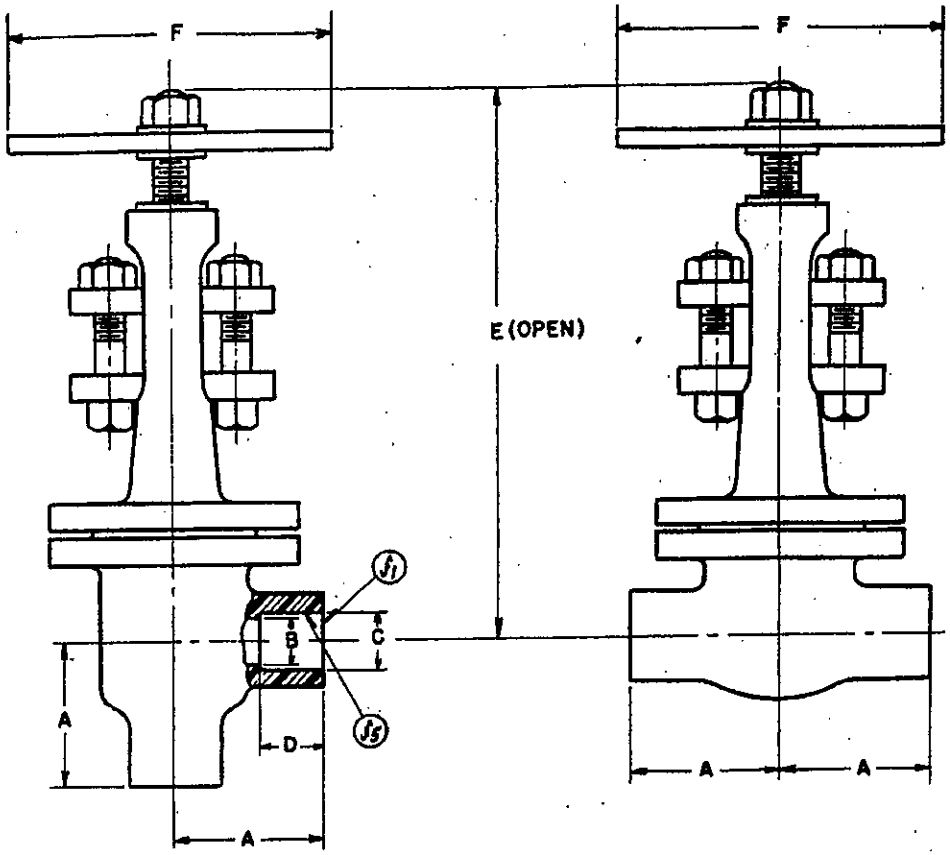

ALL DIMENSIONS IN INCHES							
SIZE	A	B	C	D	E		F
					GLOBE	ANGLE	
$\frac{1}{4}$	2	$\frac{5}{16}$	.55	$\frac{7}{16}$	6	$5\frac{5}{8}$	*3
$\frac{3}{8}$	$2\frac{1}{8}$	$\frac{7}{16}$	.685	$\frac{9}{16}$	$6\frac{1}{4}$	$5\frac{7}{8}$	*4
$\frac{1}{2}$	$2\frac{5}{16}$	$\frac{19}{32}$	.855	$\frac{5}{8}$	$7\frac{3}{8}$	$6\frac{3}{4}$	5
$\frac{3}{4}$	$2\frac{7}{8}$	$\frac{13}{16}$	1.07	$\frac{11}{16}$	$9\frac{1}{8}$	$8\frac{1}{8}$	6
1	$3\frac{1}{2}$	$1\frac{1}{16}$	1.335	$\frac{3}{4}$	11	$9\frac{5}{8}$	7

*MINIMUM LENGTH OF TEE HANDLES $2\frac{1}{2}$ INCHES AND 4 INCHES, RESPECTIVELY.

FIG. 1

10 November 1937 45V19(INT)

BUREAU OF ENGINEERING SPECIFICATION

VALVES, HIGH PRESSURE, GLOBE AND ANGLE, FORGED STEEL, WELDING ENDS,

SIZES, 1/4-INCH TO 1-INCH INCLUSIVE

600 Lbs. W.S.P. and 850° F. Maximum Temperature

(SHIPBOARD USE)

A. APPLICABLE SPECIFICATIONS AND DRAWINGS.

A-1. The following specifications, of the issue in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies.

NAVY DEPARTMENT SPECIFICATIONS

General Specifications for Inspection of Material, together with Appendix II (Metals).
42S5 - Screws, machine.
43B11 - Bolts, nuts, studs and tap rivets (and material for same).
43B14 - Bolt studs, steel rods and nuts for service at temperatures up to 850°F.
45V18 - Valves, high pressure, globe and angle, steel (Shipboard use).
46A1 - Aluminum alloy, light castings.
46B6 - Brass, naval, rolled: Bars, plates, etc.
46B10 - Brass, naval: Castings.
46-I-8 - Iron, malleable: Castings.
46M6 - Metal, gun: Castings.
46M7 - Nickel-copper alloy, rolled.
46P1 - Plating, cadmium.
46R5 - Rods, welding, cobalt-chromium composition.
46S18 - Steel, corrosion-resisting; bars, rods and forgings (except for reforging)
46S33 - Steel castings, molybdenum alloy (for temperatures up to 850° F.).
46S34 - Steel forgings, molybdenum alloy (for temperatures up to 850° F.).
49S1 - Steel: Castings.
49S2 - Steel: Forgings for hulls, engines, and ordnance.

BUREAU OF ENGINEERING SPECIFICATIONS

General Specifications for Machinery, Subsection S1-1.

A-2. The following Bureau of Engineering drawings, of the latest alteration in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies:

B-64 - Handwheels for valves.
B-100- Finish marks.
B-147- Seamless drawn steel tubing.
B-153- Standard application of annual contract packing.
3-S-530- Forged steel welding end fittings.

B. TYPE.

B-1. Valves covered by this specification shall be furnished in but one type.

C. MATERIAL AND WORKMANSHIP.

C-1. Departures from Referenced Specifications.- The use of materials differing from the referenced Navy Department specifications will be considered when it can be clearly demonstrated that an improvement in operating characteristics, or a saving in weight without sacrifice in reliability can be accomplished thereby, or that such substitutes do not preclude the subsequent use of Navy standard materials in effecting repairs or replacements necessitated by service wear. Specific approval shall be obtained where departures are made from the referenced specifications.

C-2. Materials.- All materials used in the construction of valves shall be as specified in Section E. Alternate materials will be considered in lieu of those specified but their use will only be permitted after the Bureau has been satisfied by test or other means that the proposed substitutes fully meet the service requirements.

C-3. Threaded Parts; Standard Bolts, Nuts and Machine Screws.- Bolts and nuts shall conform to F.D. Specs. 46B11 or 46B14, referred to in Section A, as applicable. All threaded parts shall be assembled with the use of a suitable high temperature thread lubricant satisfactory to the Bureau.

C-4. Workmanship.- All parts shall be free from flaws, burrs, and blemishes. The workmanship shall be first class in every respect.

D. GENERAL REQUIREMENTS.

D-1. (See Section E).

E. DETAIL REQUIREMENTS.

E-1. Plans.- Plans shall be furnished as required by the bureau concerned.

E-1a. Bureau of Engineering.

E-1a(1). The number, size, arrangement, title, form, etc., shall conform to the requirements of Subsection S1-1, referred to in Section A.

E-1a(2). The specific plans desired, except as provided by subparagraphs E-1a(3) and E-1a(4), shall include the following:

Type A.
Type B.
Type D.

E-1a(3). Type A drawings shall accompany bids, except when the bidder has filed with the Bureau approved drawings of the valves, in which case it will suffice to quote the Bureau file numbers of the drawings for identification that the valves have been approved by the Bureau and meet these specifications.

E-1a(4). Type B and Type D drawings will not be required provided the contractor has filed with the Bureau approved drawings of the valves.

E-2. The materials shall conform to the following:

(a) Body and bonnet.- Class A forged carbon-molybdenum steel (N.D. Specs.46S34).
(b) Bonnet bolt-studs and nuts.- Steel (N.D. Spec. 43B14).
(c) Bonnet yoke bushing.- Gun metal (N.D. Spec. 46M6).
(d) Bonnet gasket.- Soft steel or iron sheet; nickel-copper alloy sheet, (N.D. Spec. 46M7), dead soft annealed; or copper-nickel zinc sheet of approximately 64 percent copper, 50 percent nickel and 6 percent zinc. Brinell 80 or less for all.
(e) Disk.- Cast carbon-molybdenum steel, (N.D.Spec. 46S33) or forged carbon-molybdenum steel (N.D. Spec. 46S34); (see item 7 for seating face).
(f) Disk nut.- Forged steel, Class C (N.D. Spec. 49S2).
(g) Disk and seat, seating faces.- Cobalt-chromium composition (N.D. Spec.46R5).
(h) Flange bolt - studs and nuts.- (Bureau Standard Sheet B-174).
(i) Gland, stuffing box.- Class C cast of forged steel (electro-galvanized) (N.D. Spec. 49S1).
(j) Gland bolts.- Steel, Class B (N.D. Spec. 43B11), cadmium plated (N.D. Spec. 46P1); nuts - steel, Class C (N.D. Spec. 43B11), cadmium plated (N.D. Spec. 46P1); or Naval brass (N.D. Spec. 46B6).
(k) Handwheels.- See Bureau Standard Sheet B-64.
(l) Lock washer for disk nut.- Corrosion-resisting steel, Grade 1, (N.D. Spec. 46S18).
(m) Set screws and split pins.- Steel.
(n) Stem bushing.- Special nickel-copper alloy, 52 to 56 percent nickel, 30.5 to 34 percent copper, 10.5 to 13 percent tin, 0.35 to 1 percent silicon, 0.30 to 0.75 percent manganese, 0.40 to 1 percent phosphorous and 1 to 2 percent iron. Minimum tensile strength 60,000 pounds per square inch. Brinell 190 to 235. Other materials satisfactory for the service will be given consideration.
(o) Stem for disk.- Forged corrosion-resisting steel, grade 7, (N.D. Spec.46S18)
(p) Stem nuts.- Naval brass (N.D. Spec. 46B6).
(q) Washer between end of rotating stem and disk.- Nitralloy or equivalent, at least 800 Brinell hardness.
(r) T-handles.- Naval brass (N.D. Spec. 46B10), or malleable iron (N.D. Spec. 46-I-8).

E-3. Valves shall be so designed as to insure positive tightness under severe service.

E-4. The bodies of all valves shall be so fitted that the valves may be easily ground in.

E-5. The characteristic dimensions of all valves shall be as given in Figure 1.

E-6. Bodies and bonnets shall be forged.

E-7. The unrestricted area through the seats, with the disk in the full open position, and through all body passages, shall be not less than that given in column "B" of the table shown on Figure 1.

E-8. Valves shall have bolted bonnets. The joint faces for bonnet flanges shall be male and female and shall have (f3) finish; see Bureau Standard Sheet B-100, referred to in Section A. The bonnets shall be secured by studs or bolt-studs.

E-9. Yokes shall be integral with the bonnets, but a design with separate yoke will be given consideration. The yoke shall be fitted with a bushing threaded to suit the stem.

E-10. Stems shall have outside acme type of threads unless otherwise approved, and shall turn right-hand to close the valves.

E-11. Valve disks shall be of the plug type with swivel attachment to the stems and the seating area faced with cobalt-chromium composition not less than 3/32-inch thick for 1-inch and 3/4-inch valves, and 1/16 inch thick for valves 1/2-inch and smaller; the composition to be deposited by welding to insure positive bond between it and the disk. Disks shall be secured to the stems by nuts locked in place; other means for securing disks for 1/4-inch and 3/8-inch valves will be considered if the method is described in the bid. A hardened washer shall be inserted between the end of all stems and disks for valves 3/4-inch and larger to prevent galling.

E-12. Valve seats shall be integral with the bodies. The seating area shall be faced with cobalt chromium composition in compliance with similar requirements for the disks; see paragraph E-11. The included seat angle shall be 30 to 60 degrees.

E-13. Stuffing boxes shall be of ample depth for at least six turns of packing, except 1/4-inch valves which shall have at least four turns. Stuffing boxes shall be arranged so that they can be packed when under pressure with the valve open. Valves shall be delivered with stuffing boxes suitably packed. The packing shall be as approved; see Bureau Standard Sheet B-153, referred to in Section A. Stuffing box glands shall be secured and adjusted by studs, and nuts.

E-14. Handwheels.- Handwheels shall conform to Bureau Standard Sheet B-64, referred to in Section A. The minimum diameters shall be as given in the table shown on Figure 1. All handwheels shall have the rims and the upper face of hubs finished and buffed and the spokes and unfinished portion of the hubs wire brushed, unless required to be finished and buffed all over. All handwheels shall be secured by means of a hexagonal nut threaded to the stem. T-handles may be used instead of handwheels for 1/4-inch and 3/8-inch valves.

F. METHODS OF SAMPLING, INSPECTION AND TESTS.

F-1. Chemical and physical tests shall be made as required by the specifications covering the various materials used.

F-2. Five percent of the initial quantity of valves on order for any new design shall be selected by the Naval Inspector and tested to a steam pressure of 600 pounds per square inch gage, at a temperature of 850°F. Such test shall include tests for tightness on both sides of the disk, and tightness of the body. On subsequent cumulative orders, on the same manufacturer for valves of the same design a total of five percent of each size of valve so ordered shall be given the above steam test. This shall be interpreted to mean that of each one hundred valves of the same size and design ordered, the Inspector may select at his discretion five valves to be steam tested. Valves so selected may be taken from one order or from a multiplicity of orders totalling one hundred valves as desired, the number tested being a percentage of the total runs of valves and not a percentage of each individual order.

F-3. All valves shall be tested as follows:

(a) By hydrostatic pressure to at least 1500 pounds per square inch for strength and porosity with the disk open.
(b) By hydrostatic pressure to at least 750 pounds per square inch for tightness on seat with the disk closed by hand and without the use of a wrench or equivalent, the pressure shall be applied alternately on both sides of the disk with the side opposite the pressure open for inspection in each case.
(c) By air pressure to approximately 100 pounds per square inch for porosity and tightness on seat, procedure to be as outlined in (b) above.

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT.

G-1. Packing.- Unless otherwise specified, the subject commodity shall be delivered in substantial wooden crates or boxes, so constructed as to insure safe delivery by common or other carrier to the point of delivery. Not more than five valves shall be packed in a container. The valves shall be packed rigidly, or secured in the containers in such a manner as will prevent damage from shifting while being handled or transported. Sets of spare parts, if furnished, shall be packaged or bagged, and secured to the valve to which they belong.

G-2. Marking.- Unless otherwise specified, shipping containers shall be marked with the name of the material, the type, size, and the quantity contained therein as defined by the contract or order under which the shipment is made, the name of the contractor, and the number of the contract or order, and the net and gross weight.

H. NOTES.

H-1. Requisitions and contracts or orders should state the number of Type B and D drawings desired. See subparagraphs E-1a(3) and E-1a(4).

H-2. This specification supersedes Supplementary General Specification for Machinery, SGS(48)-155 formerly issued by the Bureau of Engineering, Navy Department, Washington, D.C.

H-3. Copies of Drawings and Specifications.

H-3a. Copies of Drawings.- Copies of Bureau of Engineering drawings may be obtained only upon application to the Bureau of Engineering, Navy Department, Washington, D.C. When requesting, refer to drawings by both title and number.

H-3b. Copies of Bureau of Engineering Specifications.- Copies of Bureau of Engineering specifications may be obtained only upon application to the Bureau of Engineering, Navy Department, Washington, D.C. When requesting, refer to specification by both title and number.

H-3c. Copies of Navy Department Specifications.- Copies of Navy Department specifications may be obtained upon application to the Bureau of Supplies and Accounts, Navy Department, Washington, D.C., except that naval activities should make application to the Commandant, Navy Yard, New York, N.Y. When requesting, refer to specification by both title and number.

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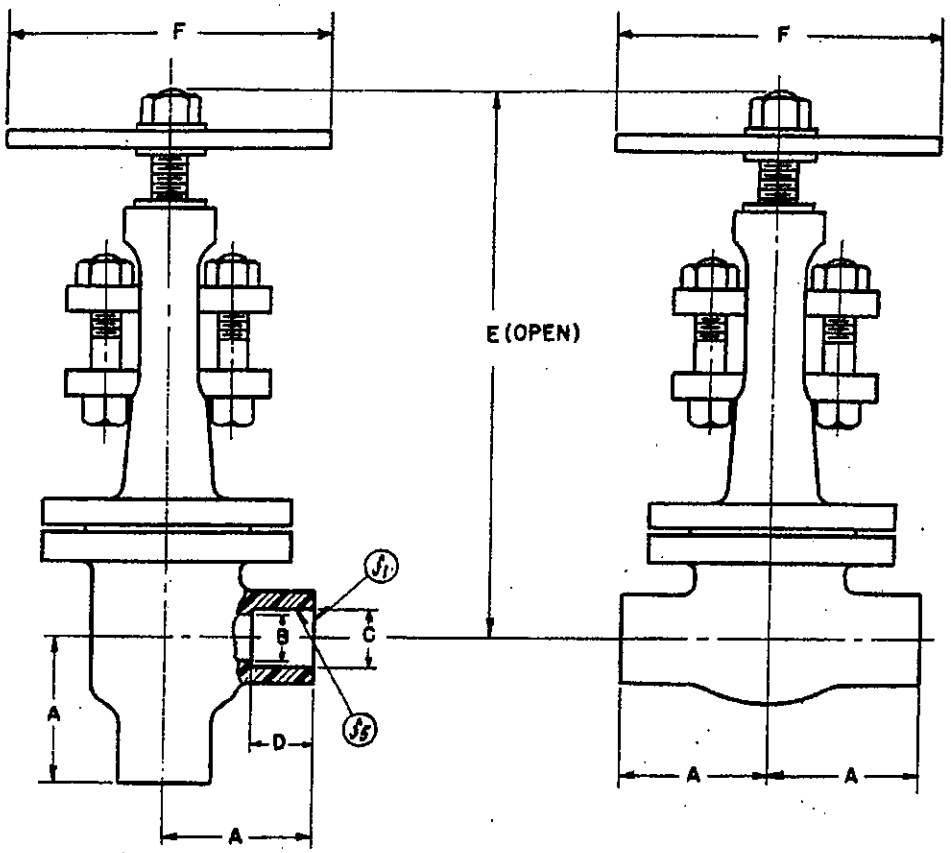

ALL DIMENSIONS IN INCHES							
SIZE	A	B	C	D	E		F
					GLOBE	ANGLE	
$\frac{1}{4}$	2	$\frac{5}{16}$	.55	$\frac{7}{16}$	6	$5\frac{5}{8}$	*3
$\frac{3}{8}$	$2\frac{1}{8}$	$\frac{7}{16}$	.685	$\frac{9}{16}$	$6\frac{1}{4}$	$5\frac{7}{8}$	*4
$\frac{1}{2}$	$2\frac{5}{16}$	$\frac{19}{32}$	.855	$\frac{5}{8}$	$7\frac{3}{8}$	$6\frac{3}{4}$	5
$\frac{3}{4}$	$2\frac{7}{8}$	$\frac{13}{16}$	1.07	$\frac{11}{16}$	$9\frac{1}{8}$	$8\frac{1}{8}$	6
1	$3\frac{1}{2}$	$1\frac{1}{16}$	1.335	$\frac{3}{4}$	11	$9\frac{5}{8}$	7

*MINIMUM LENGTH OF TEE HANDLES $2\frac{1}{2}$ INCHES AND 4 INCHES, RESPECTIVELY.

FIG. 1

15 May 1938 45V17(INT)

BUREAU OF ENGINEERING SPECIFICATION

VALVES, GATE, FOR AIR EXHAUST STEAM, OIL, OR WATER SERVICES

(SHIPBOARD USE)

A. APPLICABLE SPECIFICATIONS AND DRAWINGS.

A-1. The following specifications, of the issue in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies.

NAVY DEPARTMENT SPECIFICATIONS

General Specifications for Inspection of Material, together with Appendix II (Metals).
33P14 - Packing, asbestos, valve stem, symbol 1101.
33P16 - Packing, asbestos, rod, high pressure, symbol 1100.
33P17 - Packing, metallic, flexible, symbols 1430 and 1431.
43B11 - Bolts, nuts, studs, tap rivets (and material for same).
43B14 - Bolt-studs, nuts, and rod; steel (for service at temp. up to 850° F.)
44T2 - Threads, standard, for pipe and pipe fittings.
45V1 - Valves, bronze, 100 W.S.P., gate.
46B6 - Brass, Naval, rolled.
46B8 - Bronze, valve: Castings.
46M6 - Metal, gun: Castings.
46M7 - Nickel-copper alloy; rods, bars, shapes, etc.
46S18 - Steel, corrosion-resisting; bars, rods, and forgings, (except for reforging).
46S27 - Steel, corrosion-resisting: Castings.
49S1 - Steel; castings.
49S2 - Steel; forgings for hulls, engines and ordnance.

BUREAU OF ENGINEERING SPECIFICATIONS

General Specifications for Machinery, Subsection S1-1.

A-2. The following Bureau of Engineering drawings, of the alteration in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies:

B-64 - Hand wheels for valves.
B-139 - Composition flanges, 100 lbs.
B-140 - Composition flanges, 400 lbs.
B-141 - Steel flanges, 400 lbs.
P-153 - Standard application of annual contract packings.
B-159 - Steel flanges, 600 lbs.
B-160 - Type quick closing valves.
B-161 - Type hose gate valve.
B-173 - Forged steel unions.

B-174 - Steel flanges, 750 lbs.
S-S-530 - Forged steel welding end fittings.
6-Y-554 - Schedule for piping, pipe fittings, valves, etc.

B. CLASSES.

B-1. Gate valves shall be of the following classes:

Class I - For working pressures not greater than 100 pounds per square inch threaded and flanged ends - composition. (also in steel for oil services, as required by schedule for valves, etc., Bureau drawing 6-Y-554 as listed in Section A.)
Class II - For working pressures from 101 to 200 pounds per square inch, smaller than 2 inch size, threaded ends - composition.
Class III - For working pressures from 101 to 400 pounds per square inch threaded, and flanged ends - composition.
Class IV - For working pressures from 101 to 400 pounds per square inch, sizes 3/4 inch and larger, flanged ends - cast (or forged) steel.
Class V - For working pressures from 401 to 600 pounds per square inch, sizes 3/4-inch and larger, flanged ends - cast (or forged) steel.
Class VI - For working pressures from 601 to 750 pounds per square inch, sizes 3/4-inch and larger, flanged ends - cast (or forged) steel.

C. MATERIAL AND WORKMANSHIP.

C-1. Material. Unless otherwise approved, all materials used in the construction of valves shall be as specified in Section E.

C-2. Workmanship.- All castings shall be clean, sound and free from blow holes, porosity, cracks and any other injurious defects. The workmanship shall be first class in all respects.

D. GENERAL REQUIREMENTS.

D-1. Plans.- Plans shall be furnished as required by the bureau concerned.

D-1a. Bureau of Engineering.

D-1a(1). The number, size, arrangement, title, form, etc., shall conform to the requirements of Subsection S1-1, referred to in Section A.

D-1a(2). The specific plans desired and the information thereon shall include the following:

Type A.
Type B.
Type D.

D-1a(3). Type A drawings shall accompany bids.

D-1a(4). The number of sets of Type B and Type D drawings, if required, shall be stated in the requisition, contract or order.

D-2. All valves shall be of the non-rising stem design and so constructed that the stem will not be exposed to the fluid passing through the valve, except that entering the drain hole, when the disk is raised to the full open position.

D-3. All valves when fully open shall permit an unobstructed flow and the area at any point within the valve shall be not less than the inside area of the pipe or tubing to which connected.

D-4. All valves shall be so designed that the valve stem may be packed when the valve is in the full open position.

D-5. All disks shall be of the wedge-type double faced design, made in one piece.

D-6. All valves shall be provided with disk guides cast integral with the body.

D-7. Each disk shall have an opening in the bottom to provide drainage.

D-8. Each stem shall be so threaded with acme type threads that the valve will be opened when the handwheel is turned counter-clockwise. The end of each stem shall be square and tapered to fit the handwheel. The stem shall be threaded above the tapered section to provide for a hexagonal securing nut.

D-9. The stem and thrust collar shall be one integral piece.

D-10. Unless otherwise specified, each valve 2-1/2 inches and larger shall be provided with an indicator to show whether the valve is open or closed.

D-11. Each valve shall have distinctly cast or stamped one one side of the body, the size, the trade mark of the maker "100" for Class I valves, "200" for Class II valves, "400" for Class III valves, "400" for Class IV valves, "600" for Class V valves, and "750" for Class VI valves; and the size of the valve. Valves for oil shall also have the word 'oil' cast or stamped on the bodies.

D-12. Faces of all flanges shall have at least a fine tool finish.

D-13. The walls of bodies and bonnets shall be curved surfaces; no flat surfaces shall be permitted. They shall be ribbed as required to prevent distortion.

D-14. Stuffing boxes shall be separate from the valve bonnets. For valves of 2-1/2 inch size, and above, the glands shall be of the flanged type set up by two nuts working on studs extending through the gland flange.

D-15. All composition gate valves of 2-1/2 inch size and above, and all steel gate valves shall have removable seats. Removable seats shall be screwed into the valve bodies, suitable lugs being provided on the seats for the purpose. The faces of the seats shall be slightly raised at the center to provide a narrow bearing surface not to exceed one-eighth inch in width.

D-16. All gate valves, Classes III, IV, V and VI, 4-1/2 inch size or larger shall be fitted with by passes. The by-pass valves shall be globe valves, the materials of which shall correspond to the gate valves served. The minimum sizes for the by-passes are given below in Table I.

TABLE I.

Size of gate valve	Size of by-pass valve
4-1/2 inches to 7-1/2 inches, incl.	1/2 inch, minimum
8 inches to 9-1/2 inches, incl.	3/4 inch, minimum
10 inches	1 inch, minimum

NOTE. - All by-passes shall be connected to their valves by flanged joints.

D-17. Valve stems shall be packed with one of the packings conforming to N.D. Specs. 33P14, 33P16, or 33P17, referred to in Section A.

E. DETAIL REQUIREMENTS.

E-1. Class I Gate Valves.-

E-1a. Valves shall conform in every particular to N.D. Spec. 45V1, referred to in Section A, except those ordered in steel, which shall conform to N.D. Spec. 45V1 for design and subparagraph E-4c(1) for materials, except that the "bolts" or "studs" and "nuts", shall be steel, N.D. Spec. 43311, referred to in Section A, Classes B and C, respectively.

E-2. Class II Gate Valves.

E-2a. Valves shall be supplied only with threaded ends and in sizes and with dimensions shown in Table II.

TABLE II.

Size of pipe for which valves are used	Dimensions	
	Diameter of handwheel-minimum	Distance centerline to top maximum
Inches	Inches	Inches
1/4	1-1/2	4
1/2	1-3/4	4-1/4
3/4	2-1/2	5
1	2-3/4	5-3/4
1-1/4	3	6-1/2
1-1/2	3-1/2	7-1/2

E-2b. The threaded ends shall conform to the requirements of N.D. Spec. 44T2, referred to in Section A.

E-2c. Materials shall be the same as those specified for Class I gate valves.

E-2d. Bonnets may be screwed, or flanged and bolted.

E-2e. Handwheels shall be of malleable iron of non-heat design having three or more spokes. See Table II for minimum diameters.

E-3. Class III Gate Valves

E-3a. Valves shall be supplied with threaded or flanged ends as specified in sizes 1-1/2 inches and smaller; and with flanged ends only in sizes 2 inches and above. The dimensions shall conform to those shown in Table III.

TABLE III.

Size of pipe or tubing for which used	Dimensions			
	Flanged valves		Handwheel	Height - Centerline to top - maximum
	Diam. of bore	Face to face	Diameter - minimum	
Inches	Inches	Inches	Inches	Inches
1/4	---	---	1-3/4	8
1/2	---	---	2-1/2	8-1/2
3/4	1	5	2-3/4	9
1	1-1/4	5-1/4	3	10-1/2
1-1/4	1-1/2	6	3-1/2	11
1-1/2	2	7	4	12
2	2-1/2	7-1/2	8	13
2-1/2	3	8	9	15
3	3-1/2	8-1/2	10	16
3-1/2	4	9	11	17
4	4-1/2	9-1/2	11	18-1/2
4-1/2	5	10	12	20
5	5-1/2	10-1/4	12	21-1/2
5-1/2	6	10-1/2	14	23
6	6-1/2	10-3/4	16	24-1/2
6-1/2	7	11	18	26
7	7-1/2	11-1/4	18	27-1/2
7-1/2	8	11-1/2	18	29
8	8-1/2	11-3/4	21	30-1/2
8-1/2	9	12	21	32
9	9-1/2	12-1/2	21	33-1/2
9-1/2	10	13	21	35
10	10-1/2	13-1/2	21	36-1/2

E-3b. The threaded ends shall conform to the requirements of N.D. Spec. 44T2, referred to in Section A.

E-3c. The dimensions of flanges shall conform to Bureau of Engineering drawing B-140, referred to in Section A.

E-3d. Unless otherwise specified, valves shall be delivered with the flanges indrilled.

E-3e. Materials shall be the same as those specified for Class I valves.

E-3f. Bonnets for valves 1-1/2 inches and smaller may be screwed. Those for valves 2 inches and larger shall be flanged. Flanged bonnets shall be bolted with bolt studs threaded full length and fitted with a nut on each end.

E-3g. Handwheels for valves, sizes 1-1/2 inches and smaller, shall be of the same type as specified for Class II valves. Handwheels for valves, sizes 2 inches and larger, shall conform to Bureau of Engineering drawing B-64, referred to in Section A, and shall have diameters not less than those given in Table III.

E-4. Class IV Gate Valves.

E-4a. Valves shall have flanged ends and be made only of steel, cast or forged, in all sizes and of dimensions as shown in Table IV.

TABLE IV.

Size of pipe or tubing for which used	Dimensions			
	Diameter of Bore	Face to Face	Handwheel Diameter Minimum	Height - Centerline to Top - Maximum
Inches	Inches	Inches	Inches	Inches
3/4	1	5	3-1/4	10
1	1-1/4	5-1/4	4	11
1-1/4	1-1/2	6	5	11-1/2
1-1/2	2	7	6	12-1/2
2	2-1/2	7-1/2	8	13-1/2
2-1/2	3	8	9	15-1/2
3	3-1/2	8-1/2	10	16-1/2
3-1/2	4	9	11	17-1/2
4	4-1/2	9-1/2	11	19
4-1/2	5	10	12	20-1/2
5	5-1/2	10-1/4	12	22
5-1/2	6	10-1/2	14	23-1/2
6	6-1/2	10-3/4	16	25
6-1/2	7	11	18	26-1/2
7	7-1/2	11-1/4	18	28
7-1/2	8	11-1/2	18	29-1/2
8	8-1/2	11-3/4	21	31
8-1/2	9	12	21	32-1/2
9	9-1/2	12-1/2	21	34
9-1/2	10	13	21	35-1/2
10	10-1/2	13-1/2	21	37

E-4b. The dimension of flanges shall conform to Bureau of Engineering drawing B-141, referred to in Section A.

E-4c. Unless otherwise specified, valves shall be delivered with the flanges undrilled.

E-4d. Materials shall be as follows:

(1) Oil Service.
Body bonnet, stuffing box and gland - Class B cast steel (N.D. Spec. 49S1) or Class B forged steel (N.D. Spec. 49S2).
Disk and seat - Grade 7 corrosion-resisting steel (N.D. Spec. 46S18) or Grade 7 corrosion-resisting steel, cast (N.D. Spec. 46S27), The disk may be Class B cast steel (N.D. Spec. 49S1) fitted with seating face of either of the former materials.
Stem - Grade 7 corrosion-resisting steel (N.D. Spec. 46S18).
Stem nut, index unit and scale - brass.
Bolt-studs and nuts - steel, (N.D. Spec. 43B14).
Bolts and nuts - (N.D. Spec. 43B11).

(2) Air, Exhaust Steam or Water Services.
Body, bonnet and stuffing box - same materials as specified for "Oil Service".
Disk and seat - Gun metal (N.D. Spec. 46M6) or special composition of non-galling characteristics as approved.
Stem - nickel-copper alloy, rolled (N.D. Spec. 46M7).
Stuffing box gland, stem nut, index units and scale - brass.
Bolt -studs and nuts - steel (N.D. Spec. 43B14).
Bolt and nuts - (N.D. Spec. 43B11).

E-4e. Bonnets shall be flanged and bolted with bolt studs threaded full length and fitted with a nut on each end.

E-4f. Handwheels shall conform to Bureau of Engineering drawing B-64, referred to in Section A, and shall have diameters not less than those given in Table IV.

E-5. Class V Gate Valves.

E-5a. Valves shall have flanged ends, shall be made in all sizes, and shall be of the dimensions given in Table V.

TABLE V.

Size of pipe or tubing for which used	Dimensions: Diameter of Bore	Face to face over raised surface	Handwheel Diameter Minimum	Height Center-line to top - maximum
Inches	Inches	Inches	Inches	Inches
3/4	3/4	7-1/2	6	8-1/2
1	1	8-1/2	7	9-1/2
1-1/4	1-1/4	9	7	11
1-1/2	1-1/2	9-1/2	8	12-1/2
2	2	11-1/2	8	15
2-1/2	2-1/2	13	9	16-5/8
3	3	14	10	18-1/4
3-1/2	3-1/2	15	10	19
4	4	16	12	22
4-1/2	4-1/2	17	12	24
5	5	18	14	26
5-1/2	5-1/2	19	16	27-1/4
6	6	19-1/2	16	28-1/4
6-1/2	6-1/2	20-1/2	18	30
7	7	21-1/2	18	31
7-1/2	7-1/2	22-1/2	18	33
8	8	23-1/2	21	35
8-1/2	8-1/2	24-1/4	21	36
9	9	25	21	37
9-1/2	9-1/2	25-3/4	21	38
10	10	26-1/2	21	39

E-5b. The dimensions of flanges shall conform to Bureau of Engineering drawings B-159 and 3-S-530 referred to in Section A. Raised surfaces on all valve flanges shall be 1/4-inch in height.

E-5c. Valves shall be furnished with flanges drilled; bolt holes to straddle the center lines.

E-5d. Materials shall be the same as specified for Class IV valves.

E-5e. Bonnets shall be bolted with bolt-studs threaded full length and fitted with a nut on each end.

E-5f. Handwheels shall conform to Bureau of Engineering drawing 3-64, referred to in Section A, and shall have diameters not less than those given in Table V.

E-6. Class VI Gate Valves.

E-6a. Valves shall have flanged ends, shall be made in all sizes, and shall be of the dimensions given in Table VI.

TABLE VI.

Size of pipe or tubing for which used	Dimensions: Diameter of bore	Face to face over raised surface	Handwheels Diameter, minimum	Height centerline to top - maximum
Inches	Inches	Inches	Inches	Inches
3/4	3/4	7-1/2	6	10-1/2
1	1	8-1/2	7	11
1-1/4	1-1/4	9	7	11-1/2
1-1/2	1-1/2	9-1/2	8	13
2	2	11-1/2	9	16-1/2
2-1/2	2-1/2	13	9	17
3	3	14	10	19
3-1/2	3-1/2	15-1/2	12	19-1/2
4	4	17	14	24
4-1/2	4-1/2	18-1/2	14	26
5	5	20	16	28
5-1/2	5-1/2	21	18	29
6	6	22	18	30-1/2
6-1/2	6-3/8	23	21	32-1/2
7	6-7/8	24	21	33-1/2
7-1/2	7-3/8	25	21	35-1/2
8	7-7/8	26	24	37-1/2
8-1/2	8-3/8	27-1/4	24	38-1/2
9	8-3/4	28-1/2	24	39-1/2
9-1/2	9-1/4	29-3/4	24	40-1/2
10	9-3/4	31	27	41-1/2

E-6b. The dimensions of flanges shall conform to Bureau of Engineering drawings B-174 and 3-S-530, referred to in Section A. Raised faces on all valves shall be 1/4-inch in height.

E-6c. Valves shall be furnished with flanges drilled; bolt holes to straddle the center lines.

E-6d. Materials shall be the same as specified for Class IV valves.

E-6e. Bonnets shall be bolted with bolt-studs threaded full length and fitted with a nut on each end.

E-6f. Handwheels shall conform to Bureau of Engineering drawing B-64, referred to in Section A, and shall have diameters not less than those given in Table VI.

F. METHODS OF SAMPLING, INSPECTION AND TESTS.

F-1. Chemical and physical tests shall be made on samples of material taken during manufacture as required by the specifications covering the various materials used.

F-2. Each valve shall be inspected for defects of workmanship and compliance with specified dimensions.

F-3. Each valve shall be tested as follows:

(a) By hydrostatic pressure, as tabulated below, for strength and porosity with the gate open.

(b) By hydrostatic pressure, as tabulated below, for tightness on seat with the gate closed by hand and without the use of a wrench or equivalent, the pressure to be applied alternately on both sides of the gate with the side opposite the pressure open for inspection in each case.

Hydrostatic Test Pressure

	(1) Open	(2) Closed
Class I	200 lbs. per sq. in. gage	100 lbs. per sq. in. gage
Class II	300 lbs. per sq. in. gage	200 lbs. per sq. in. gage
Class III	600 lbs. per sq. in. gage	400 lbs. per sq. in. gage
Class IV	750 lbs. per sq. in. gage	400 lbs. per sq. in. gage
Class V	1000 lbs. per sq. in. gage	500 lbs. per sq. in. gage
Class VI	1500 lbs. per sq. in. gage	750 lbs. per sq. in. gage

F-4. The appliance for the hydrostatic testing of flanged valves shall not restrict longitudinal expansion.

G. PACKAGING, PACKING AND MARKING FOR SHIPMENT.

G-1. Packing.- Unless otherwise specified, the subject commodity shall be delivered in substantial wooden containers so constructed as to insure safe delivery by common or other carriers to the point of delivery at the lowest rate, and to withstand further shipment and handling if necessary without repacking. A single container, when packed for shipment, shall weigh not in excess of approximately 250 pounds gross. Valves weighing in excess of 125 pounds each shall be packed singly. Not more than one size, type, or kind of valves shall be packed in a single container.

G-2. Marking.- Unless otherwise specified, shipping containers shall be marked with the name of the material, the class, size and the quantity contained therein as defined by the contract or order under which shipment is made, the name of the contractor, the number of the contract or order and the gross weight.

H. NOTES.

H-1. Requisitions and contracts or orders should state the quantity of each class and the size of valves desired and the number of Type B and D drawings desired.

H-2. This specification supersedes Supplementary General Specification for Machinery, SGS(48)-20 formerly issued by the Bureau of Engineering, Navy Department, Washington, D.C.

H-3. Copies of Drawings and Specifications.

H-3a. Copies of Drawings.- Copies of Bureau of Engineering drawings may be obtained only upon application to the Bureau of Engineering, Navy Department, Washington, D.C. When requesting refer to drawings by both title and number.

H-3b. Copies of Bureau of Engineering Specifications.- Copies of Bureau of Engineering Specifications may be obtained only upon application to the Bureau of Engineering, Navy Department, Washington, D.C. When requesting, refer to Specification by both title and number.

H-3c. Copies of Navy Department Specifications.- Copies of Navy Department Specifications may be obtained upon application to the Bureau of Supplies and Accounts, Navy Department, Washington, D.C., except that Naval activities should make application to the Commandant, Navy Yard, New York, N.Y. When requesting, refer to specification by both title and number.

15 January 1938 45V17(IET)

BUREAU OF ENGINEERING SPECIFICATION

VALVES, GATE, FOR WATER, OIL, EXHAUST STEAM OR AIR SERVICES

(SHIPBOARD USE)

A. APPLICABLE SPECIFICATIONS AND DRAWINGS.

A-1. The following specifications, of the issue in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies.

NAVY DEPARTMENT SPECIFICATIONS

General Specifications for Inspection of Material, together with Appendix II (Metals).
33P14 - Packing, asbestos, valve stem, symbol 1101.
33P16 - Packing, asbestos, rod, high pressure, symbol 1100.
33P17 - Packing, metallic, flexible, symbols 1430 and 1431.
43B11 - Bolts, nuts, studs, tap rivets (and material for same).
43B14 - Bolt-studs, nuts, and rod; steel (for service at temp. up to 850° F.)
44T2 - Threads, standard, for pipe and pipe fittings.
45V1 - Valves, bronze, 100 W.S.P., gate.
46B6 - Brass, naval, rolled.
46B8 - Bronze, valve: Castings.
46M6 - Metal, gun: Castings.
46M7 - Nickel-copper alloy; rods, bars, shapes, etc.
46S18 - Steel, corrosion-resisting; bars, rods, and forgings (except for reforging).
46S27 - Steel, corrosion-resisting: Castings.
49S1 - Steel; Castings.
49S2 - Steel; Forgings for hulls, engines and ordnance.

BUREAU OF ENGINEERING SPECIFICATIONS

General Specifications for Machinery, Subsection S1-1.

A-2. The following Bureau of Engineering drawings, of the latest alteration in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies:

B-64 - Hand wheels for valves.
B-139 - Composition flanges, 100 lbs.
B-140 - Composition flanges, 200 and 400 lbs.
B-141 - Steel flanges, 400 lbs.
B-153 - Standard application of annual contract packings.
B-159 - Steel flanges, 600 lbs.
B-160 - Type quick closing valves.
B-161 - Type hose gate valve.
B-173 - Forged steel unions.

B-174 - Steel flanges.
3-S-530 - Forged steel welding end fittings.
6-Y-554 - Schedule for piping, pipe fittings, valves and type of joints used in piping systems.

B. CLASSES.

B-1. Gate valves shall be of the following classes:

Class I - For working pressures not greater than 100 pounds per square inch threaded and flanged ends - composition. (also in steel for oil services, as required by schedule for valves, etc., Bureau drawing 6-Y-554 as listed in Section A.)
Class II - For working pressures from 101 to 200 pounds per square inch, smaller than 2 inch size, threaded ends - composition.
Class III - For working pressures from 101 to 400 pounds per square inch threaded, and flanged ends - composition.
Class IV - For working pressures from 101 to 400 pounds per square inch, sizes 3/4 inch and larger, flanged ends - cast (or forged) steel.
Class V - For working pressures from 401 to 600 pounds per square inch, sizes 3/4 inch and larger, flanged ends - cast (or forged) steel.
Class VI - For working pressures from 601 to 750 pounds per square inch, sizes 3/4 inch and larger, flanged ends - cast (or forged) steel.

C. MATERIAL AND WORKMANSHIP.

C-1. Departures from Referenced Specifications.- The use of materials differing from the referenced Navy Department specifications will be considered when it can be clearly demonstrated that an improvement in operating characteristics, or a saving in weight without sacrifice in reliability can be accomplished thereby, or that such substitutes do not preclude the subsequent use of Navy standard materials in effecting repairs or replacements necessitated by service wear. Specific approval shall be obtained where departures are made from the referenced specifications.

C-2. Materials.- All materials used in the construction of valves shall be as specified in Section E. Alternate materials will be considered in lieu of those specified but their use will only be permitted after the bureau concerned has been satisfied by test or other means that the proposed substitutes fully meet the service requirements.

C-3. Threaded Parts; Standard Bolts, Nuts and Machine Screws.- Bolts and nuts shall conform to N.D. Specs. 43B11, and 43B14 referred to in Section A.

C-4. Workmanship.- All castings shall be clean, sound and free from blow holes, porosity, cracks and any other injurious defects. The workmanship shall be first class in all respects.

D. GENERAL REQUIREMENTS.

D-1. Plans.- Plans shall be furnished as required by the bureau concerned.

D-1a. Bureau of Engineering.

D-1a(1). The number, size, arrangement, title, form, etc., shall conform to the requirements of Subsection S1-1, referred to in Section A.

D-1a(2). The specific plans desired and the information thereon shall include the following:

Type A.
Type B.
Type D.

D-1a(3). Type A drawings shall accompany bids.

D-1a(4). The number of sets of Type B and Type D drawings, if required, shall be stated in the requisition, contract or order.

D-2. All valves shall be of the non-rising stem design and so constructed that the stem will not be exposed to the fluid passing through the valve, except that entering the drain hole, when the disk is raised to the full open position.

D-3. All valves when fully open shall permit an unobstructed flow and the area at any point within the valve shall be not less than the inside area of the pipe or tubing to which connected.

D-4. All valves shall be so designed that the valve stem may be packed when the valve is in the full-open position.

D-5. All disks shall be of the wedge-type double-faced design, made in one piece.

D-6. All valves shall be provided with disk guides cast integral with the body.

D-7. Each disk shall have an opening in the bottom to provide drainage.

D-8. Each stem shall be so threaded with acme type threads that the valve will be opened when the handwheel is turned counterclockwise. The end of each stem shall be square and tapered to fit the handwheel. The stem shall be threaded above the tapered section to provide for a hexagonal securing nut.

D-9. The stem and thrust collar shall be one integral piece.

D-10. Unless otherwise specified, each valve 2-1/2 inches and larger shall be provided with an indicator to show whether the valve is open or closed.

D-11. Each valve shall have distinctly cast or stamped on one side of the body, the size, the trade mark of the maker, "100" for Class I valves, "200" for Class II valves, "400" for Class III valves, "300" for Class IV valves, "400" for Class V valves, and "600" for Class VI valves; and the size of the valve. Valves for oil shall also have the word 'oil' cast or stamped on the bodies.

D-12. The walls of bodies and bonnets shall be curved surfaces; no flat surfaces shall be permitted. They shall be ribbed as required to prevent distortion.

D-13. Stuffing boxes shall be separate from the valve bonnets. For valves of 2-1/2 inch size, and above, the glands shall be of the flanged type set up by two nuts working on studs extending through the gland flange.

D-14. All composition gate valves of 2-1/2 inch size and above, and all steel gate valves shall have removable seats. Removable seats shall be screwed into the valve bodies, suitable lugs being provided on the seats for the purpose. The faces of the seats shall be slightly raised at the center to provide a narrow bearing surface not to exceed one-eighth inch in width.

D-15. All gate valves, Classes III, IV, V and VI, 4-1/2 inch size or larger shall be fitted with by passes. The by-pass valves shall be globe valves, the materials of which shall correspond to the gate valves served. The minimum sizes for the by-passes are given below in Table I.

TABLE I.

Size of gate valve	Size of by-pass valve
4-1/2 inches to 7-1/2 inches, incl.	1/2 inch, minimum
8 inches to 9-1/2 inches, incl.	3/4 inch, minimum
10 inches	1-inch, minimum

NOTE:- All by-passes shall be connected to their valves by flanged joints.

D-16. Valves stems shall be packed with one of the packings conforming to N.D. Specs. 33P14, 33P16, or 33P17, referred to in Section A.

E. DETAIL REQUIREMENTS.

E-1. Class I Gate Valves.

E-1a. Valves shall conform in every particular to N.D. Specs. 45V1, referred to in Section A, except when ordered in steel, which shall conform to N.D. Specs. 45V1 for design and subparagraph E-4c(1) for materials, but the "bolts" or "studs" and "nuts", shall be steel, N.D. Specs. 43B11, referred to in Section A, Classes B and C, respectively.

E-2. Class II Gate Valves.

E-2a. Valves shall be supplied only with threaded ends and in sizes and with dimensions shown in Table II.

TABLE II.

Size of Pipe for which Valves are used	Dimensions	
	Diameter of handwheel-minimum	Distance centerline to top maximum
Inches	Inches	Inches
1/4	1-1/2	4
1/2	1-3/4	4-1/4
3/4	2-1/2	5
1	2-3/4	5-3/4
1-1/4	3	6-1/2
1-1/2	3-1/2	7-1/2

E-2b. The threaded ends shall conform to the requirements of N.D. Specs. 44T2, referred to in Section A.

E-2c. Materials shall be the same as those specified for Class I gate valves.

E-2d. Bonnets may be screwed, or flanged and bolted.

E-2e. Handwheels shall be of malleable iron of non-heat design having three or more spokes. See Table II for minimum diameters.

E-3. Class III Gate Valves.

E-3a. Valves shall be supplied with threaded or flanged ends as specified in sizes 1-1/2 inches and smaller; and with flanged ends only in sizes 2 inches and above. The dimensions shall conform to those shown in Table III.

TABLE III.

Size of Pipe or Tubing for which used	Dimensions			
	Flanged Valves		Handwheel	Height - Centerline
	Diam. of Bore	Face to Face	Diameter- minimum	to Top-Maximum
Inches	Inches	Inches	Inches	Inches
1/4	---	---	1-3/4	8
1/2	---	---	2-1/2	8-1/2
3/4	1	5	2-3/4	9
1	1-1/4	5-1/4	3	10-1/2
1-1/4	1-1/2	6	3-1/2	11
1-1/2	2	7	4	12
2	2-1/2	7-1/2	8	13
2-1/2	3	8	9	15
3	3-1/2	8-1/2	10	16
3-1/2	4	9	11	17
4	4-1/2	9-1/2	11	18-1/2
4-1/2	5	10	12	20
5	5-1/2	10-1/4	12	21-1/2
5-1/2	6	10-1/2	14	23
6	6-1/2	10-3/4	16	24-1/2
6-1/2	7	11	18	26
7	7-1/2	11-1/4	18	27-1/2
7-1/2	8	11-1/2	18	29
8	8-1/2	11-3/4	21	30-1/2
8-1/2	9	12	21	32
9	9-1/2	12-1/2	21	33-1/2
9-1/2	10	13	21	35
10	10-1/2	13-1/2	21	36-1/2

E-3b. The threaded ends shall conform to the requirements of N. D. Specs. 44T2, referred to in Section A.

E-3c. The dimensions of flanges shall conform to Bureau standard B-140, referred to in Section A.

E-3d. Materials shall be the same as those specified for Class I valves.

E-3e. Bonnets for valves 1-1/2 inches and smaller may be screwed. Those for valves 2 inches and larger shall be flanged. Flanged bonnets shall be bolted with bolt studs threaded full length and fitted with a nut on each end.

E-3f. Handwheels for valves, sizes 1-1/2 inches and smaller, shall be of the same type as specified for Class II valves. Handwheels for valves, sizes 2 inches and larger, shall conform to Bureau standard B-64, referred to in Section A, and with diameters not less than those given in Table III.

E-4. Class IV Gate Valves.

E-4a. Valves shall have flanged ends and be supplied only of steel, cast or forged, in all sizes and of dimensions as shown in Table IV.

TABLE IV.

Size of Pipe or Tubing for which used	Dimensions			
	Diameter of Bore	Face to Face	Handwheel: Diameter Minimum	Height-Centerline to top-maximum
Inches	Inches	Inches	Inches	Inches
3/4	1	5	3-1/4	10
1	1-1/4	5-1/4	4	11
1-1/4	1-1/2	6	5	11-1/2
1-1/2	2	7	6	12-1/2
2	2-1/2	7-1/2	8	13-1/2
2-1/2	3	8	9	15-1/2
3	3-1/2	8-1/2	10	16-1/2
3-1/2	4	9	11	17-1/2
4	4-1/2	3-1/2	11	19
4-1/2	5	10	12	3C-1/2
5	5-1/2	10-1/4	12	22
5-1/2	6	10-1/2	14	23-1/2
6	6-1/2	10-3/4	16	25
6-1/2	7	11	18	26-1/2
7	7-1/2	11-1/4	18	28
7-1/2	8	11-1/2	18	29-1/2
8	8-1/2	11-3/4	21	31
8-1/2	9	12	21	32-1/2
9	9-1/2	12-1/2	21	34
9-1/2	10	13	21	35-1/2
10	10-1/2	13-1/2	21	37

E-4b. The dimension of flanges shall conform to Bureau standard B-141, referred to in Section A.

E-4c. Materials shall be as follows:

(1) Oil Service.
Body, bonnet, stuffing box and gland - Class D cast steel (N.D. Specs. 49S1) or Class B forged steel (N.D. Specs. 49S2).
Disk and seat - CRS-1 corrosion-resisting steel (N.D. Specs. 46S18) or free maching cast corrosion-resisting steel (N.D. Specs. 46S27), The disk may be Class D cast steel (N.D. Specs. 49S1) fitted with seating face of either of the former materials.
Stem - CRS-7 corrosion-resisting steel (N.D. Specs. 46S18).
Stem nut, index unit and scale - brass.
Bolt-studs and nuts - steel, (N.D. Specs. 43B14).
Bolts and nuts - (N.D. Specs. 43B11).

(2) Air, Exhaust Steam or Water Services.
Body, bonnet and stuffing box -same materials as specified for "Oil Service".
Disk and seat - Gun metal (N.D. Specs. 46M6) or special composition of non-galling characteristics as approved.
Stem - nickel-copper alloy, rolled (N.D. Specs. 46M7).
Stuffing box gland, stem nut, index units and scale - brass.
Bolt-studs and nuts - steel (N.D. Specs. 43B14).
Bolt and nuts - (N.D. Specs. 43B11).

E-4d. Bonnets shall be flanged and bolted with bolt studs threaded full length and fitted with a nut on each end.

E-4e. Handwheels shall conform to Bureau standard B-64, referred to in Section A, and with diameters not less than those given in Table IV.

E-5. Class V Gate Valves.

E-5a. Valves shall have flanged ends and be made in all sizes and of the dimensions given in Table V.

TABLE V.

Size of Pipe or Tubing for which used	Dimensions			
	Diameter of Bore	Face to face over raised surface	Handwheel Diameter Minimum	Height Center-line to top - maximum
Inches	Inches	Inches	Inches	Inches
3/4	3/4	7-1/2	6	8-1/2
1	1	8-1/2	7	9-1/2
1-1/4	1-1/4	9	7	11
1-1/2	1-1/2	9-1/2	8	12-1/2
2	2	11-1/2	8	15
2-1/2	2-1/2	13	9	16-5/8
3	3	14	10	18-1/4
3-1/2	3-1/2	15	10	19
4	4	16	12	22
4-1/2	4-1/2	17	12	24
5	5	18	14	26
5-1/2	5-1/2	19	16	27-1/4
6	6	19-1/2	16	28-1/4
6-1/2	6-1/2	20-1/2	18	30
7	7	21-1/2	18	31
7-1/2	7-1/2	22-1/2	18	33
8	8	23-1/2	21	35
8-1/2	8-1/2	24-1/4	21	36
9	9	25	21	37
9-1/2	9-1/2	25-3/4	21	38
10	10	26-1/2	21	39

E-5b. The dimensions of flanges shall conform to Bureau drawings B-159 and 3-S-530 referred to in Section A. Raised surfaces on all valve flanges shall be 1/4 inch in height.

E-5c. Materials shall be the same as specified for Class IV valves.

E-5d. Bonnets shall be bolted with bolt-studs threaded full length and fitted with a nut on each end.

E-5e. Handwheels shall conform to Bureau standard B-64, referred to in Section A, and with diameters not less than those given in Table V.

E-6. Class VI Gate Valves.

E-6a. Valves shall have flanged ends and be made in all sizes and of the dimensions given in Table VI.

TABLE VI.

Size of pipe or tubing for which used	Dimensions			
	Diameter of bore	Face to face over raised surface	Handwheel Diameter, minimum	Height centerline to top - maximum
Inches	Inches	Inches	Inches	Inches
3/4	3/4	7-1/2	6	10-1/3
1	1	8-1/2	7	11
1-1/4	1-1/4	9	7	11-1/2
1-1/2	1-1/2	9-1/2	8	13
2	2	11-1/2	9	16-1/2
2-1/2	2-1/2	13	9	17
3	3	14	10	19
3-1/2	3-1/2	15-1/2	12	19-1/2
4	4	17	14	24
4-1/2	4-1/2	18-1/2	14	26
5	5	20	16	28
5-1/2	5-1/2	21	18	29
6	6	22	18	30-1/2
6-1/2	6-3/8	23	21	32-1/2
7	6-7/8	24	21	33-1/2
7-1/2	7-3/8	25	21	35-1/2
8	7-7/8	26	24	37-1/2
8-1/2	8-3/8	27-1/4	24	38-1/2
9	8-3/4	28-1/2	24	39-1/2
9-1/2	9-1/4	29-3/4	24	40-1/2
10	9-3/4	31	27	41-1/2

E-6b. The dimensions of flanges shall conform to Bureau drawings B-174 and 3-S-530, referred to in Section A. Raised faces on all valves shall be 1/4-inch in height.

E-6c. Materials shall be the same as specified for Class IV valves.

E-6d. Bonnets shall be bolted with bolt-studs threaded full length and fitted with a nut on each end.

E-6e. Handwheels shall conform to Bureau standard B-64, referred to in Section A, and with diameters not less than those given in Table VI.

F. METHODS OF SAMPLING, INSPECTION AND TESTS.

F-1. Chemical and physical tests shall be made on samples of material taken during manufacture as required by the specifications covering the various materials used.

F-2. Each valve shall be inspected for defects of workmanship and compliance with specified dimensions.

F-3. Each valve shall be tested as follows:

(a) By hydrostatic pressure, as tabulated below, for strength and porosity with the gate open.

(b) By hydrostatic pressure, as tabulated below, for tightness on seat with the gate closed by hand and without the use of a wrench or equivalent, the pressure to be applied alternately on both sides of the gate with the side opposite the pressure open for inspection in each case.

Hydrostatic Test Pressures

	(1) Open	(2) Closed
Class I	150 lbs. per sq. in. gage	100 lbs. per sq. in. gage
Class II	300 lbs. per sq. in. gage	200 lbs. per sq. in. gage
Class III	600 lbs. per sq. in. gage	400 lbs. per sq. in. gage
Class IV	750 lbs. per sq. in. gage	400 lbs. per sq. in. gage
Class V	1000 lbs. per sq. in. gage	500 lbs. per sq. in. gage
Class VI	1500 lbs. per sq. in. gage	750 lbs. per sq. in. gage

F-4. The appliance for the hydrostatic testing of flanged valves shall not restrict longitudinal expansion.

G. PACKAGING, PACKING AND MARKING FOR SHIPMENT.

G-1. Packing.- Unless otherwise specified, valves shall be delivered in substantial commercial containers so constructed as to insure acceptance by common or other carrier for safe transportation at the lowest rate to the point of delivery.

G-2. Marking.- Unless otherwise specified, shipping containers shall be marked with the name of the material, the class, size and the quantity contained therein as defined by the contract or order under which shipment is made, the name of the contractor and the number of the contract or order.

H. NOTES.

H-1. Requisitions and contracts or orders should state the quantity of each class and the size of valves desired and the number of Type B and D drawings desired.

H-2. This specification supersedes Supplementary General Specification for Machinery, SGS(48)-20 formerly issued by the Bureau of Engineering, Navy Department, Washington, D. C.

H-3. Copies of Drawings and Specifications.-

H-3a. Copies of Drawings.- Copies of Bureau of Engineering drawings may be obtained only upon application to the Bureau of Engineering, Navy Department, Washington, D. C. When requesting, refer to drawings by both title and number.

H-3b. Copies of Bureau of Engineering Specifications.- Copies of Bureau of Engineering Specifications may be obtained only upon application to the Bureau of Engineering, Navy Department, Washington, D. C. When requesting, refer to Specification by both title and number.

H-3c. Copies of Navy Department Specifications.- Copies of Navy Department Specifications may be obtained upon application to the Bureau of Supplies and Accounts, Navy Department, Washington, D. C. When requesting, refer to specification by both title and number.

10 November 1937 45V17(INT)

BUREAU OF ENGINEERING SPECIFICATION

VALVES, GATE, FOR WATER, OIL, EXHAUST STEAM OR AIR SERVICES

(SHIPBOARD USE)

A. APPLICABLE SPECIFICATIONS AND DRAWINGS.

A-1. The following specifications, of the issue in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies.

NAVY DEPARTMENT SPECIFICATIONS

General Specifications for Inspection of Material, together with Appendix II (Metals).
33P14 - Packing, asbestos, valve stem, symbol 1101.
33P16 - Packing, asbestos, rod, high pressure, symbol 1100.
33P17 - Packing, metallic, flexible, symbols 1430 and 1431.
43B11 - Bolts, nuts, studs, tap rivets (and material for same).
43B14 - Bolt-studs, nuts, and rod; steel (for service at temp. up to 850° F.)
44T2 - Threads, standard, for pipe and pipe fittings.
45V1 - Valves, bronze, 100 W.S.P., gate.
46B6 - Brass, naval, rolled.
46B8 - Bronze, valve: Castings.
46M6 - Metal, gun: Castings.
46M7 - Nickel-copper alloy; rods, bars, shapes, etc.
46S18 - Steel, corrosion-resisting; bars, rods, and forgings (except for reforging).
46S27 - Steel, corrosion-resisting: Castings.
49S1 - Steel; Castings.
49S2 - Steel; Forgings for hulls, engines and ordnance.

BUREAU OF ENGINEERING SPECIFICATIONS

General Specifications for Machinery, Subsection S1-1.

A-2. The following Bureau of Engineering drawings, of the latest alteration in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies:

B-64 - Hand wheels for valves.
B-139 - Composition flanges, 100 lbs.
B-140 - Composition flanges, 200 and 400 lbs.
B-141 - Steel flanges, 400 lbs.
B-153 - Standard application of annual contract packings.
B-159 - Steel flanges, 600 lbs.
B-160 - Type quick closing valves.
B-161 - Type hose gate valve.
B-173 - Forged steel unions.

B-174 - Steel flanges.
3-S-530 - Forged steel welding end fittings.
6-Y-554 - Schedule for piping, pipe fittings, valves and type of joints used in piping systems.

B. CLASSES.

B-1. Gate valves shall be of the following classes:

Class I - For working pressures not greater than 100 pounds per square inch threaded and flanged ends - composition. (also in steel for oil services, as required by schedule for valves, etc., Bureau drawing 6-Y-554 as listed in Section A.)
Class II - For working pressures from 101 to 200 pounds per square inch, smaller than 2 inch size, threaded ends - composition.
Class III - For working pressures from 101 to 400 pounds per square inch threaded, and flanged ends - composition.
Class IV - For working pressures from 101 to 400 pounds per square inch, sizes 3/4 inch and larger, flanged ends - cast (or forged) steel.
Class V - For working pressures from 401 to 600 pounds per square inch, sizes 3/4 inch and larger, flanged ends - cast (or forged) steel.
Class VI - For working pressures from 601 to 750 pounds per square inch, sizes 3/4 inch and larger, flanged ends - cast (or forged) steel.

C. MATERIAL AND WORKMANSHIP.

C-1. Departures from Referenced Specifications.- The use of materials differing from the referenced Navy Department specifications will be considered when it can be clearly demonstrated that an improvement in operating characteristics, or a saving in weight without sacrifice in reliability can be accomplished thereby, or that such substitutes do not preclude the subsequent use of Navy standard materials in effecting repairs or replacements necessitated by service wear. Specific approval shall be obtained where departures are made from the referenced specifications.

C-2. Materials.- All materials used in the construction of valves shall be as specified in Section E. Alternate materials will be considered in lieu of those specified but their use will only be permitted after the bureau concerned has been satisfied by test or other means that the proposed substitutes fully meet the service requirements.

C-3. Threaded Parts; Standard Bolts, Nuts and Machine Screws.- Bolts and nuts shall conform to N.D. Specs. 43B11, and 43B14 referred to in Section A.

C-4. Workmanship.- All castings shall be clean, sound and free from blow holes, porosity, cracks and any other injurious defects. The workmanship shall be first class in all respects.

D. GENERAL REQUIREMENTS.

D-1. Plans. Plans shall be furnished as required by the bureau concerned.

D-1a. Bureau of Engineering.

D-1a(1). The number, size, arrangement, title, form, etc., shall conform to the requirements of Subsection S1-1, referred to in Section A.

D-1a(2). The specific plans desired and the information thereon shall include the following:

Type A.
Type B.
Type D.

D-1a(3). Type A drawings shall accompany bids.

D-1a(4). The number of sets of Type B and Type D drawings, if required, shall be stated in the requisition, contract or order.

D-2. All valves shall be of the non-rising stem design and so constructed that the stem will not be exposed to the fluid passing through the valve, except that entering the drain hole, when the disk is raised to the full open position.

D-3. All valves when fully open shall permit an unobstructed flow and the area at any point within the valve shall be not less than the inside area of the pipe or tubing to which connected.

D-4. All valves shall be so designed that the valve stem may be packed when the valve is in the full-open position.

D-5. All disks shall be of the wedge-type double-faced design, made in one piece.

D-6. All valves shall be provided with disk guides cast integral with the body.

D-7. Each disk shall have an opening in the bottom to provide drainage.

D-8. Each stem shall be so threaded with acme type threads that the valve will be opened when the handwheel is turned counterclockwise. The end of each stem shall be square and tapered to fit the handwheel. The stem shall be threaded above the tapered section to provide for a hexagonal securing nut.

D-9. The stem and thrust collar shall be one integral piece.

D-10. Unless otherwise specified, each valve 2-1/2 inches and larger shall be provided with an indicator to show whether the valve is open or closed.

D-11. Each valve shall have distinctly cast or stamped on one side of the body the trade mark of the maker, "100" for Class I valves, "200" for Class II valves, "400" for Class III valves, "300" for Class IV valves, "400" for Class V valves, and "600" for Class VI valves; and the size of the valve. Valves for oil shall also have the word 'oil' cast or stamped on the bodies.

D-12. The walls of bodies and bonnets shall be curved surfaces; no flat surfaces shall be permitted. They shall be ribbed as required to prevent distortion.

D-13. Stuffing boxes shall be separate from the valve bonnets. For valves of 2-1/2 inch size, and above, the glands shall be of the flanged type set up by two nuts working on studs extending through the gland flange.

D-14. All composition gate valves of 2-1/2 inch size and above, and all steel gate valves shall have removable seats. Removable seats shall be screwed into the valve bodies, suitable lugs being provided on the seats for the purpose. The faces of the seats shall be slightly raised at the center to provide a narrow bearing surface not to exceed one-eighth inch in width.

D-15. All gate valves, Classes III, IV, V and VI, 4-1/2 inch size or larger shall be fitted with by passes. The by-pass valves shall be globe valves, the materials of which shall correspond to the gate valves served. The minimum sizes for the by-passes are given below in Table I.

TABLE I.

Size of gate valve	Size of by-pass valve
4-1/2 inches to 7-1/2 inches, incl.	1/2 inch, minimum
8 inches to 9-1/2 inches, incl.	3/4 inch, minimum
10 inches	1-inch, minimum

NOTE:- All by-passes shall be connected to their valves by flanged joints.

D-16. Valves stems shall be packed with one of the packings conforming to N.D. Specs. 33P14, 33P16, or 33P17, referred to in Section A.

E. DETAIL REQUIREMENTS.

E-1. Class I Gate Valves.

E-1a. Valves shall conform in every particular to N.D. Specs. 45V1, referred to in Section A, except when ordered in steel, which shall conform to N.D. Specs. 45V1 for design and subparagraph E-4c(1) for materials, but the "bolts" or "studs" and "nuts", shall be steel, N.D. Specs. 43E11, referred to in Section A, Classes B and C, respectively.

E-2. Class II Gate Valves.

E-2a. Valves shall be supplied only with threaded ends and in sizes and with dimensions shown in Table II.

TABLE II.

Size of Pipe for which Valves are used	Dimensions	
	Diameter of handwheel-minimum	Distance centerline to top maximum
Inches	Inches	Inches
1/4	1-1/2	4
1/2	1-3/4	4-1/4
3/4	2-1/2	5
1	3-3/4	5-3/4
1-1/4	3	6-1/2
1-1/2	3-1/2	7-1/2

E-2b. The threaded ends shall conform to the requirements of N.D. Specs. 44T2, referred to in Section A.

E-2c. Materials shall be the same as those specified for Class I gate valves.

E-2d. Bonnets may be screwed, or flanged and bolted.

E-2e. Handwheels shall be of malleable iron of non-heat design having three or more spokes. See Table II for minimum diameters.

E-3. Class III Gate Valves.

E-3a. Valves shall be supplied with threaded or flanged ends as specified in sizes 1-1/2 inches and smaller; and with flanged ends only in sizes 2 inches and above. The dimensions shall conform to those shown in Table III.

TABLE III.

Size of Pipe or Tubing for which used	Dimensions			
	Flanged Valves		Handwheel	Height - Centerline
	Diam. of Bore	Face to Face	Diameter- minimum	to Top-Maximum
Inches	Inches	Inches	Inches	Inches
1/4	---	---	1-3/4	8
1/2	---	---	2-1/2	8-1/2
3/4	1	5	2-3/4	9
1	1-1/4	5-1/4	3	10-1/2
1-1/4	1-1/2	6	3-1/2	11
1-1/2	2	7	4	12
2	2-1/2	7-1/2	8	13
2-1/2	3	8	9	15
3	3-1/2	8-1/2	10	16
3-1/2	4	9	11	17
4	4-1/2	9-1/2	11	18-1/2
4-1/2	5	10	12	20
5	5-1/2	10-1/4	12	21-1/2
5-1/2	6	10-1/2	14	23
6	6-1/2	10-3/4	16	24-1/2
6-1/2	7	11	18	26
7	7-1/2	11-1/4	18	27-1/2
7-1/2	8	11-1/2	18	29
8	8-1/2	11-3/4	21	30-1/2
8-1/2	9	12	21	32
9	9-1/2	12-1/2	21	33-1/2
9-1/2	10	13	21	35
10	10-1/2	13-1/2	21	36-1/2

E-3b. The threaded ends shall conform to the requirements of N. D. Specs. 44T2, referred to in Section A.

E-3c. The dimensions of flanges shall conform to Bureau standard B-140, referred to in Section A.

E-3d. Materials shall be the same as those specified for Class I valves.

E-3e. Bonnets for valves 1-1/2 inches and smaller may be screwed. Those for valves 2 inches and larger shall be flanged. Flanged bonnets shall be bolted with bolt studs threaded full length and fitted with a nut on each end.

E-3f. Handwheels for valves, sizes 1-1/2 inches and smaller, shall be of the same type as specified for Class II valves. Handwheels for valves, sizes 2 inches and larger, shall conform to Bureau standard B-64, referred to in Section A, and with diameters not less than those given in Table III.

E-4. Class IV Gate Valves.

E-4a. Valves shall have flanged ends and be supplied only of steel, cast or forged, in all sizes and of dimensions as shown in Table IV.

TABLE IV.

Size of Pipe or Tubing for which used	Dimensions			
	Diameter of Bore	Face to Face	Handwheel Diameter Minimum	Height-Centerline to top-maximum
Inches	Inches	Inches	Inches	Inches
3/4	1	6	3-1/4	10
1	1-1/4	5-1/4	4	11
1-1/4	1-1/2	6	5	11-1/2
1-1/2	2	7	6	12-1/2
2	2-1/2	7-1/2	8	13-1/2
2-1/2	3	8	9	15-1/2
3	3-1/2	8-1/2	10	16-1/2
3-1/2	4	9	11	17-1/2
4	4-1/2	9-1/2	11	19
4-1/2	5	10	12	20-1/2
5	5-1/2	10-1/4	12	22
5-1/2	6	10-1/2	14	23-1/2
6	6-1/2	10-3/4	16	25
6-1/2	7	11	18	26-1/2
7	7-1/2	11-1/4	18	28
7-1/2	8	11-1/2	18	29-1/2
8	8-1/2	11-3/4	21	31
8-1/2	9	12	21	32-1/2
9	9-1/2	12-1/2	21	34
9-1/2	10	13	21	35-1/2
10	10-1/2	13-1/2	21	37

E-4b. The dimension of flanges shall conform to Bureau standard B-141, referred to in Section A.

E-4c. Materials shall be as follows:

(1) Oil Service.
Body, bonnet, stuffing box and gland - Class D cast steel (N.D. Specs. 49S1) or Class B forged steel (N.D. Specs. 49S2).
Disk and seat - CRS-1 corrosion-resisting steel (N.D. Specs. 46S18) or free maching cast corrosion-resisting steel (N.D. Specs. 46S27), The disk may be Class D cast steel (N.D. Specs. 49S1) fitted with seating face of either of the former materials.
Stem - CRS-7 corrosion-resisting steel (N.D. Specs. 46S18).
Stem nut, index unit and scale - brass.
Bolt-studs and nuts - steel, (N.D. Specs. 43B14).
Bolts and nuts - (N.D. Specs. 43B11).

(2) Air, Exhaust Steam or Water Services.
Body, bonnet and stuffing box -same materials as specified for "Oil Service".
Disk and seat - Gun metal (N.D. Specs. 43M6) or special composition of non-galling characteristics as approved.
Stem - nickel-copper alloy, rolled (N.D. Specs. 46M7).
Stuffing box gland, stem nut, index units and scale - brass.
Bolt-studs and nuts - steel (N.D. Specs. 43B14).
Bolt and nuts - (N.D. Specs. 43B11).

E-4d. Bonnets shall be flanged and bolted with bolt studs threaded full length and fitted with a nut on each end.

E-4e. Handwheels shall conform to Bureau standard B-64, referred to in Section A, and with diameters not less than those given in Table IV.

E-5. Class V Gate Valves.

E-5a. Valves shall have flanged ends and be made in all sizes and of the dimensions given in Table V.

TABLE V.

Size of Pipe or Tubing for which used	Dimensions: Diameter of Bore	Face to face over raised surface	Handwheel Diameter Minimum	Height Center-line to top - maximum
Inches	Inches	Inches	Inches	Inches
3/4	3/4	7-1/2	6	8-1/2
1	1	8-1/2	7	9-1/2
1-1/4	1-1/4	9	7	11
1-1/2	1-1/2	9-1/2	8	12-1/2
2	2	11-1/2	8	15
2-1/2	2-1/2	13	9	16-5/8
3	3	14	10	18-1/4
3-1/2	3-1/2	15	10	19
4	4	16	12	22
4-1/2	4-1/2	17	12	24
5	5	18	14	26
5-1/2	5-1/2	19	16	27-1/4
6	6	19-1/2	16	28-1/4
6-1/2	6-1/2	20-1/2	18	30
7	7	21-1/2	18	31
7-1/2	7-1/2	22-1/2	18	33
8	8	23-1/2	21	35
8-1/2	8-1/2	24-1/4	21	36
9	9	25	21	37
9-1/2	9-1/2	25-3/4	21	38
10	10	26-1/2	21	39

E-5b. The dimensions of flanges shall conform to Bureau drawings B-159 and B-S-530 referred to in Section A. Raised surfaces on all valve flanges shall be 1/4 inch in height.

E-5c. Materials shall be the same as specified for Class IV valves.

E-5d. Bonnets shall be bolted with bolt-studs threaded full length and fitted with a nut on each end.

E-5e. Handwheels shall conform to Bureau standard B-64, referred to in Section A, and with diameters not less than those given in Table V.

E-6. Class VI Gate Valves.

E-6a. Valves shall have flanged ends and be made in all sizes and of the dimensions given in Table VI.

TABLE VI.

Size of pipe or tubing for which used	Dimensions: Diameter of bore	Face to face over raised surface	Handwheel Diameter, minimum	Height centerline to top - maximum
Inches	Inches	Inches	Inches	Inches
3/4	3/4	7-1/2	6	10-1/2
1	1	8-1/2	7	11
1-1/4	1-1/4	9	7	11-1/2
1-1/2	1-1/2	9-1/2	8	13
2	2	11-1/2	9	16-1/2
2-1/2	2-1/2	13	9	17
3	3	14	10	19
3-1/2	3-1/2	15-1/2	12	19-1/2
4	4	17	14	24
4-1/2	4-1/2	18-1/2	14	26
5	5	20	15	28
5-1/2	5-1/2	21	18	29
6	6	22	18	30-1/2
6-1/2	6-3/8	23	21	32-1/2
7	6-7/8	24	21	33-1/2
7-1/2	7-3/8	25	21	35-1/2
8	7-7/8	26	24	37-1/2
8-1/2	8-3/8	27-1/4	24	38-1/2
9	8-3/4	28-1/2	24	39-1/2
9-1/2	9-1/4	29-3/4	24	40-1/2
10	9-3/4	31	27	41-1/2

E-6b. The dimensions of flanges shall conform to Bureau drawings B-174 and 3-S-530, referred to in Section A. Raised faces on all valves shall be 1/4-inch in height.

E-6c. Materials shall be the same as specified for Class IV valves.

E-6d. Bonnets shall be bolted with bolt-studs threaded full length and fitted with a nut on each end.

E-6e. Handwheels shall conform to Bureau standard B-64, referred to in Section A, and with diameters not less than those given in Table VI.

F. METHODS OF SAMPLING, INSPECTION AND TESTS.

F-1. Chemical and physical tests shall be made on samples of material taken during manufacture as required by the specifications covering the various materials used.

F-2. Each valve shall be inspected for defects of workmanship and compliance with specified dimensions.

F-3. Each valve shall be tested as follows:

(a) By hydrostatic pressure, as tabulated below, for strength and porosity with the gate open.

(b) By hydrostatic pressure, as tabulated below, for tightness on seat with the gate closed by hand and without the use of a wrench or equivalent, the pressure to be applied alternately on both sides of the gate with the side opposite the pressure open for inspection in each case.

Hydrostatic Test Pressures

	(1) Open	(2) Closed
Class I	150 lbs. per sq. in. gage	100 lbs. per sq. in. gage
Class II	300 lbs. per sq. in. gage	200 lbs. per sq. in. gage
Class III	600 lbs. per sq. in. gage	400 lbs. per sq. in. gage
Class IV	750 lbs. per sq. in. gage	400 lbs. per sq. in. gage
Class V	1000 lbs. per sq. in. gage	500 lbs. per sq. in. gage
Class VI	1500 lbs. per sq. in. gage	750 lbs. per sq. in. gage

F-4. The appliance for the hydrostatic testing of flanged valves shall not restrict longitudinal expansion.

G. PACKAGING, PACKING AND MARKING FOR SHIPMENT.

G-1. Packing.- Unless otherwise specified, valves shall be delivered in substantial commercial containers so constructed as to insure acceptance by common or other carrier for safe transportation at the lowest rate to the point of delivery.

G-2. Marking.- Unless otherwise specified, shipping containers shall be marked with the name of the material, the class, size and the quantity contained therein as defined by the contract or order under which shipment is made, the name of the contractor and the number of the contract or order.

H. NOTES.

H-1. Requisitions and contracts or orders should state the quantity of each class and the size of valves desired and the number of Type B and D drawings desired.

H-2. This specification supersedes Supplementary General Specification for Machinery, SGS(48)-20 formerly issued by the Bureau of Engineering, Navy Department, Washington, D. C.

H-3. Copies of Drawings and Specifications.-

H-3a. Copies of Drawings.- Copies of Bureau of Engineering drawings may be obtained only upon application to the Bureau of Engineering, Navy Department, Washington, D. C. When requesting, refer to drawings by both title and number.

H-3b. Copies of Bureau of Engineering Specifications.- Copies of Bureau of Engineering Specifications may be obtained only upon application to the Bureau of Engineering, Navy Department, Washington, D. C. When requesting, refer to Specification by both title and number.

H-3c. Copies of Navy Department Specifications.- Copies of Navy Department Specifications may be obtained upon application to the Bureau of Supplies and Accounts, Navy Department, Washington, D. C. When requesting, refer to specification by both title and number.

Code (451)

CHANGE "BUREAU OF ENGINEERING" AND "BUREAU OF CONSTRUCTION AND REPAIR" TO READ "BUREAU OF SHIPS." (82)

S47-1

GENERAL SPECIFICATIONS FOR MACHINERY

Bureau of Engineering, Navy Department

SUBSECTION S47-1. - RECIPROCATING PUMPS, DIRECT-ACTING STEAM AND MOTOR DRIVEN

1 March 1939

(Superseding Subsection S47-1. - Reciprocating Displacement Pumps, Direct-Action Steam and Motor-Driven; of 1 April 1934.)

GENERAL REQUIREMENTS

S47-1-a. Reference subsections.

Issue in effect, including changes in effect, on date of invitation for bids shall govern. (Copies obtainable only from the Bureau of Engineering.)

S47-1-b. Reference Navy Department Specifications (N. D. Specs.)

Issue in effect on date of invitation for bids shall govern. (Copies obtainable from the Bureau of Supplies and Accounts, Navy Department, Washington, D. C.)

1. Bearings, ball 42B5
2. Bolts, nuts, studs, and material for same 43B11
3. Bolt-studs, nuts, and bars: steel (For service at temperatures up to 850° F.) 43B14
4. Brass, naval; castings 46B10
5. Brass, naval, rolled; plates, rods, shapes, sheets, and tubing 46B6
6. Bronze, valve; castings 46B8
7. Bronze, manganese; castings 49B3
8. Bronze, manganese; rods, shapes and plates 46B15
9. Bronze, phosphor; castings 46B5
10. Bronze, phosphor, rolled or drawn; rods, sheets, and plates 46B14
11. Bronze, journal 46B9
12. Compound, rust-preventive 14C4
13. Controllers, alternating-current, (shipboard use) 17C10
14. Gages, pressure, for direct stem mounting 45G7
15. Gages, pressure and vacuum 45G1
16. Iron, gray; castings 46-I-6
17. Iron, gray, high-test (semi-steel); castings 46-I-5
18. Metal, gun; castings 46M6
19. Metal, anti-friction; ingots and castings 46M2
20. Motors and controllers, direct-current, (shipboard use) 17M9
21. Motors, alternating-current (shipboard use) 17M10
22. Nickel-copper alloy; castings 46M1
23. Nickel-copper alloy; rods, shapes, plates, sheets, and strips 46M7
24. Nickel-copper-aluminum alloy; forgings, rods, strips, and wire 46N5
25. Packing, asbestos, rod, high-pressure, symbol 1100 ..... 33P16
26. Packing, flax (symbol 1260) 33P1
27. Packing, hydraulic (symbols 1301 and 1303) 33P7
28. Packing, metallic, flexible (symbol 1430) 33P17
29. Packing, metallic and non-metallic, plastic 33P25
30. Packing, semi-metallic (symbol 1400) 33P19
31. Steel; castings 49S1
32. Steel, corrosion-resisting; bars, billets and forgings 46S18
33. Steel; forgings for hulls, engines and ordnance 49S2
34. Steel, molybdenum alloy; castings 46S33
35. Valves, pump, rubber 11V1
36. Wire, spring, phosphor-bronze 22W5

S47-1-c. General design.

1. The principle of reliability is paramount and no compromise of this principle shall be made with any other basic requirements of the design. It is the intention of this specification to obtain pumps of such a design that they will operate over a long period of years with a minimum of servicing. Where wear or erosion is unavoidable the parts subjected to such wear or erosion shall be of the best materials available for the purpose in order to reduce these detrimental effects to a minimum. The design and construction of all pumps shall be the most compact consistent with the following requirements listed in order of their importance.

(a) Reliability
(b) Accessibility for repair
(c) Resistance to wear or corrosion
(d) Economy

2. All pumps shall be of a type and make which has satisfactorily passed a test for type approval (See par. S47-1-aa), in accordance with the standard requirements for its class as set forth in paragraph S47-1-d following. For conditions governing type approval tests, see section A1.

3. Pumps will normally operate in a vertical or horizontal position, as specified, but they shall be designed to operate satisfactorily in inclined positions.

4. In purchasing a pump and its driving unit under this specification, the following information will be necessary to define fully the characteristics of the pump desired; such information will be stated in the requisition or order.

(a) Classification as per paragraph S47-1-d following, and whether horizontal or vertical.

(b) Type of drive and characteristics of power or steam supply.

(1) Direct-acting steam reciprocating driven. Steam pressure and superheat, if any, or total steam temperature. Exhaust pressure.

(2) Motor driven, gear or chain drive (specify one), and controller. Direct current - see Subsection S63-3 and N. D. Spec. 17M9. Alternating current - see Subsection S63-6 and N. D. Spec. 17M10 covering motors, and N. D. Spec. 17C10 covering controllers, including classification of motors and control equipment.

(c) Capacity, in gallons per minute. For contract purposes this shall be understood to mean the capacity of the specified liquid pumped at the maximum temperature, as determined by calibrated meter, tank, or other approved means at the pump discharge beyond the point of turbulence.

(d) Characteristics of liquid to be pumped.

(1) Description
(2) Maximum specific gravity
(3) Maximum operating temperature

(e) Discharge pressure in pounds per square inch gage. For contract purposes this shall be understood to mean the head as indicated by the corrected reading of a calibrated pressure gage connected to the pump discharge, referred to the top of the discharge valve deck, while the pump is handling the specified capacity of the required liquid at the specified temperature and suction conditions. When calculating the discharge head to be specified for a prospective installation the following factors are considered:

(1) Static discharge head; pressure corresponding to the vertical distance from the top of the discharge valve deck to the elevation at which the liquid is to be discharged. This may be negative if the delivery point is below the pump.

(2) Discharge friction loss in piping from the pump to the point of delivery.

(3) Pressure of liquid in receiving vessel at the point of discharge, into which pump discharges (if any).

(f) Suction head (or lift) in feet of liquid pumped or the equivalent pressure in pounds per square inch gage (or vacuum in inches of mercury, if lift is involved). For contract purposes this shall be understood to mean the corrected reading of a calibrated pressure (or vacuum) gage, connected at the pump suction referred to the top of the discharge valve deck while the pump is handling the specified capacity of the required liquid at the specified temperature and discharge pressure. When calculating the suction head to be specified for a prospective installation the following factors are considered:

(1) Static suction head (or lift); pressure corresponding to the vertical distance from the top of the discharge valve deck to the surface of the liquid from which the pump takes suction.

(2) Friction and entrance losses in suction piping.

(3) Pressure (or vacuum) of liquid in the vessel from which pump takes suction (if any).

(g) The approximate diameter of the steam and liquid ends together with the approximate length of stroke shall be given for steam-driven pumps based on the Bureau's experience in connection with reciprocating pumps for the required service a pump will be considered to meet this requirement if no linear dimension specified is varied by more than plus or minus 10 percent. If more or less deviation from the specified dimensions is permissible it shall be so stated in the requisition or order. All direct-acting reciprocating steam-driven pumps for general service, class II, shall have steam and liquid cylinders so proportioned that the pumps will deliver full rated discharge pressure with steam pressure at the inlet to pump reduced to 80 percent of normal.

(h) The size and location of the steam inlet, exhaust, suction and discharge connection or a statement that these shall be as approved.

(i) The operating conditions for which guarantees of overall steam or power consumption are desired and the penalty (as liquidated damages) for excess steam or power consumption.

(j) Limits of height, length and width for the unit and for disassembly of unit for normal maintenance overhaul.

(k) Maximum and/or minimum weight allowed, and, if necessary, penalty (as liquidated damages) for excess weight over the guarantees.

(l) A statement as to whether or not right-hand and left-hand units are required, and if not, that all units are to be to the same hand.

(m) A complete list of all items of equipment, not essentially parts of the pump, which the pump contractor is required to furnish. Usually mention shall be made in such a list of spare parts. Also the following items should be considered if it is desired to have the pump manufacturer or contractor supply same:

(1) Relief valves.
(2) Drain valves.
(3) Suction and discharge valves.
(4) Check valves.
(5) Air chambers.
(6) Pressure and/or vacuum gages.
(7) Thermometers and thermometer sockets.
(8) Permanently connected revolution indicators.
(9) Air or vent valves and cocks.
(10) Shifting valves.
(11) Special tools and number of sets per vessel.
(12) Indicators or indicator gear or other similar items.

5. The overall steam or power consumption of a pumping unit when operating under conditions specified in the order shall be stated in the bid and guaranteed in the contract.

6. The weight of the pumping unit complete with spare parts, but excluding spare parts boxing, shall be stated in the bid and guaranteed in the contract.

7. Electric motor-driven pumps shall be of the horizontal or vertical, single or double acting type, as specified or approved. The motor shall drive the crank shaft through suitable gearing or silent chain, as specified. The crank shaft shall be of the balanced type. Connecting rods shall be bored for crosshead or wrist pins

and the crank end shall be fitted with removable, split, bearing linings. The gear train or chain sprocket shall be designed to impart the necessary flywheel effect to the crank shaft or flywheels may be fitted, if necessary. Pumps may be either of the trunk-piston or crosshead type as approved. The complete unit shall be provided with an efficient, self-contained, forced-lubricating system. Adequate provision shall be made, by means of suitable piston-rod wipers and packing glands, or otherwise as approved, for preventing lubricating oil from the crank case being carried into the cylinders. The momentary fluctuations in pressure on the discharge of the pumps shall not exceed plus 10 percent or minus 20 percent of the rated discharge pressure.

S47-1-d. Classification.

1. The classification of pumps under this specification and a description of standard services for which reciprocating pumps may be specified or approved for shipboard service are set forth in the following table. This table should be used as a guide when ordering in accordance with paragraph S47-1-c above and when submitting designs for type approval in accordance with paragraph S47-1-aa following.

Class	Service Application of class	Discharge pressure, pounds per square inch, gage	Rated capacity, gallons per minute	Characteristics of liquid to be handled by class	Minimum suction head or maximum suction lift and max. liquid temperature	Preferred type of pump	Preferred type of drive
I	Boiler feed pumps, high pressure.	300 to 750	100 to 300	Clean fresh water	20 pounds, gage, head and 240° F. to 10" Hg. lift and 90° F.	Vertical single cylinder, double acting	Single steam cylinder, direct acting
II	General service pumps, fire, bilge, etc.	50 to 150	50 to 500	Clean seawater specific gravity 1.03, to mixtures of seawater fuel oil, dirt and sediment, specific gravity 1.06	4 feet head and 90° F. to 25" Hg. lift and 90° F.	Vertical single cylinder, double acting	Single steam cylinder, direct acting

S47-1-e. Mounting, bedplates and installation.

1. Direct-acting steam-driven pumps.

(a) All pumps shall be provided with adequate brackets for securing to the foundation or ship's structure.

(b) Special care shall be taken with the installation of pumps, to the end that the working of the vessel's structure, such as bulkheads, etc., cannot change the alignment. Due consideration must be given to the fact that a vessel laboring in a seaway will set up strains in such mounting structures. Allowance shall also be made for expansion of the pump due to temperature of the steam and liquid pumped. To this end mounting bolt holes in the pump brackets or foundation shall be suitably slotted in the direction of expansion, or other means for expansion provided, as approved.

(c) After the pumps are erected in the vessel their alignment shall be checked to insure that installation stresses have not destroyed the alignment.

(d) Pumps shall be so placed that the pistons, plungers, and valves can be readily examined, removed,and replaced.

2. Motor-driven pumps.

(a) A pump and its driving unit shall be mounted on a common bedplate (side plate for bulkhead mounting) of cast steel or structural steel fabricated by welding, designed to carry the weight of the assembly and with sufficient rigidity to insure that proper alignment of the assembled unit is maintained in service. The type, construction, and design of the bedplate or sideplate shall be clearly stated and shown on plans. All independent units of the assembly shall be centered on the bedplate or sideplate by heavy dowel pins. All top and bottom bearing surfaces of bedplate and sideplates shall be finished machined.

(b) The installation of the assembled unit with its bedplate (sideplate) shall be such that when the unit is secured to the structural foundation in the vessel a weaving of the frames cannot produce misalignment between driving and driven units.

SPECIAL REQUIREMENTS

S47-1-f. Drawings.

1. Drawings shall conform to the requirements of Subsection S1-1. The assembly drawing shall show all parts assembled in correct position, each part being identified by a part number. This assembly plan shall contain a material list in which shall appear the name of every part identified by part numbers in numerical sequence with the number of the drawing on which each part is detailed. The assembly drawing shall show all assembly clearances and shall include brief description and instructions for the operation of the pump including the steam valve gear.

2. The assembly drawing shall contain a table of operating characteristics, and table of weights. Type D drawings shall contain a set of performance curves based on data obtained on acceptance tests.

S47-1-g. Materials, workmanship and welding.

1. Materials, workmanship and welding shall conform to the requirements of Subsection S1-2.

2. All high-test gray iron castings shall be relief annealed at a temperature of not less than 900° F.

3. All steel joint pins of valve gear shall be hardened and ground to true cylindrical surfaces.

S47-1-h. Threaded parts.

1. Threaded parts shall conform to the requirements of Subsection S1-3.

S47-1-i. Preservative coatings.

1. Painting shall be in accordance with the requirements of Subsection S19-1.

2. All openings shall be closed against the ingress of moisture, and foreign matter during stowage and shipment.

3. Internal non-machined surfaces, ports, etc., shall be cleaned thoroughly of all scale, corrosion, molding sand, welding beads or other such substance which might become detached in service.

4. All finished surfaces including piston and valve rods liable to rust or corrode shall be covered with a rust preventive compound, type A, grade II, in accordance with N.D. Spec. 14C4 upon completion of acceptance tests and before shipment.

S47-1-j. Designation and marking.

1. Designation and marking shall conform to the requirements of Subsection S28-1.

S47-1-k. Heat insulation and lagging.

1. The steam cylinders and valve chests of reciprocating pumps shall be insulated and lagged in accordance with the requirements of Subsection S39-1.

2. Special care shall be taken to insure that the lagging is properly jointed to permit repair and inspection work without destroying the covering.

S47-1-*l*. Lubrication.

1. The steam valves and pistons of all pumps shall be of such design as to operate satisfactorily without lubrication.

2. A simple and effective lubrication system to use Navy lubricant shall be provided for all other working parts, which so far as practicable, shall conform to the general requirements of Subsection S45-1.

S47-1-m. Piping and valves.

1. All flanges and fittings for pipe connections shall conform to the standards of the Bureau of Engineering. (See Bureau drawing 6-Y-554).

2. All valves shall, as nearly as practicable, conform to the standards and/or specifications of the Bureau. (See Bureau drawing 6-Y-554).

3. All pumps shall be fitted with relief valves on the discharge side. They shall be located on the discharge chambers of the pumps, or on a fitting between the pump and the valve in the discharge line.

4. Relief valves shall discharge back to the suction side of the pump. An additional 1/2-inch relief valve shall be installed on the suction side of the pump between the pump and the suction line valve; this relief valve shall be set to lift at 50 pounds for pumps having a suction pressure of 40 pounds or less, and at 10 pounds above the maximum suction pressure when such suction pressure is in excess of 40 pounds. Valve overflow shall be arranged to discharge to the proper drain collecting system.

DETAIL REQUIREMENTS

S47-1-n. Materials.

1. Materials shall in general conform to the following requirements:

(a) Steam cylinders and valve chests, class B cast steel (N.D. Spec. 49S1) or class B forged steel (N. D. Spec. 49S2) for temperatures not exceeding 650° F. carbon molybdenum steel, cast (N. D. Spec. 46S33) for temperatures above 650° F.

(b) Steam cylinder and valve chest liners, high-test gray iron (N. D. Spec. — 46-I-5), or special chrome nickel cast iron, minimum hardness 200 Brinell.

(c) Steam cylinder pistons, high-test gray iron (N. D. Spec. 46-I-5), class B cast steel (N. D. Spec 49S1), or special chrome nickel cast iron.

(d) Steam valve pistons, high-test gray iron (N. D. Spec. 46-I-5) or special chrome nickel cast iron.

(e) Steam end piston rods and valve rods, class An forged steel (N. D. Spec. 49S2); nickel-copper-aluminum-alloy (N. D. Spec. 46N5) minimum hardness 265 Brinell.

(f) Steam end stuffing box bushings, nickel-copper-alloy, cast (N. D. Spec. 46M1) or rolled (N. D. Spec. 46M7).

(g) Stuffing box spacers, followers and glands, gun metal (N. D. Spec. 46M6) or valve bronze (N. D. Spec. 46B8).

(h) Crossheads, class An forged steel (N. D. Spec. 49S2) or corrosion resisting steel, grade 7 (N. D. Spec. 46S18).

(i) Liquid end piston rods, nickel-copper-aluminum-alloy (N. D. Spec. 46N4) minimum hardness 265 Brinell.

(j) Liquid end pistons, gun metal (N. D. Spec. 46M6).

(k) Liquid end cylinders, covers and valve chambers, gun metal (N. D. Spec. 46M6).

(l) Liquid cylinder liners, nickel-copper-alloy, cast (N. D. Spec. 46M1) centrifugally cast.

(m) Liquid end stuffing box throat bushings, journal bronze (N. D. Spec. 46B9) or phosphor bronze (N. D. Spec. 46B5).

(n) Pump valves, manganese bronze, cast or rolled (N. D. Specs. 49B3 or 46B15), phosphor bronze, cast or rolled (N. D. Specs 46B5 or 46B14), corrosion-resisting steel, grade 1 or 7 (N. D. Spec. 46S18), nickel-copper-alloy, cast (N. D. Spec. 46M1), or for Class II pumps only, rubber (N. D. Spec. 11V1).

(o) Pump valve seats, manganese bronze (N. D. Spec. 49B3), phosphor bronze (N. D. Spec. 46B5) or nickel-copper-alloy, cast (N. D. Spec. 46M1).

(p) Pump valve springs, phosphor-bronze (N.D. Spec. 22W5).

(q) Pump valve studs, phosphor-bronze (N. D. Spec. 46B14), nickel-copper-alloy, rolled (N. D. Spec. 46M7), or corrosion resisting steel, grade 7 (N. D. Spec. 46S18).

(r) Pump valve guards, phosphor-bronze, cast (N. D. Spec. 46B5), nickel-copper alloy, cast (N. D. Spec. 46M1) or gun metal (N. D. Spec. 46M6).

(s) Cylinder tie rods, class An forged steel (N. D. Spec. 49S2).

S47-1-o. Steam cylinders and chests.

1. Steam cylinders shall be counterbored at both ends, leaving the working bores of such length that the piston rings shall slightly override at the top and the bottom when making full stroke. All cylinders shall be lined full length with liners not less than seven-thirty-seconds inch thick supported by the cylinder throughout their length and firmly secured in a manner satisfactory to the Bureau.

2. The steam chests shall be cast separately from the cylinders and shall be secured thereto in a manner satisfactory to the Bureau. Steam chests shall be held in alignment with the cylinder in a manner satisfactory to the Bureau.

3. Bosses or brackets shall be cast on the cylinders or cylinder covers for attachment of the rods and for securing to foundations. Jack bolts and lifting bolts shall be provided as required for convenience in disassembly.

4. All cylinders and steam chest covers shall be flanged.

5. The steam and exhaust connections shall be located on the steam cylinder casting or elsewhere than on the valve chest casting so as to avoid the necessity of disconnecting steam and exhaust piping when removing steam valve gear for overhaul.

6. The lower cylinder head and valve chest to cylinder joints shall be made tight by metal to metal ground joints, without gaskets. The top cylinder head and valve chest covers may be made up with approved metal gaskets. The lower cylinder head may be cast integral with the cylinder.

7. The steam cylinders of all reciprocating pumps above 6-inches bore diameter shall be fitted with 3/4-inch diameter indicator fittings and closed with screwed plugs.

8. All parts of steam cylinders and valve chests, where condensate can accumulate, shall be provided with drain valves and pipes of ample size.

S47-1-p. Steam pistons.

1. Steam pistons shall have followers and packing ring or rings, as approved; for cylinders 6 inches in diameter or less, pistons may be of an approved box type fitted with snap rings.

2. Followers shall be secured by collar studs, and with the nuts prevented by backing off by split pins, or as approved.

3. The pistons shall be taper bored for the piston rod.

S47-1-q. Steam-valve gear.

1. The steam valve gear shall be of a compact, simple, durable and reliable type. The main steam valve shall be of the steam thrown piston type. A flat face or other type of main steam valve not inherently balanced as regards steam pressure will not be acceptable. The movement of the main steam valve shall be controlled by the alternate admission of steam to and/or the release to exhaust from opposite ends of the main valve operating piston cylinder; such admission of steam, or release to exhaust, may be controlled either by a pilot valve or automatically, by the movement of the main steam piston of the pump.

2. The pilot valve, where used, shall be of the reciprocating piston type. The pilot valve stem or link rods shall be fitted with tappets, collars, or other means satisfactory to the Bureau, for adjustment and regulation of the stroke of the pump. The pilot valve stem packing shall not be subjected to pressure in excess of the pump exhaust pressure.

3. The valve chests shall be fitted with removable liners designed in such a manner that they will serve as removable seats for the valves.

S47-1-r. Piston rods.

1. Piston rods shall be accurately finished to a true cylindrical surface. They shall be tapered on the piston ends and shall seat on a shoulder coincident with the fit on the taper, and they shall be secured in the pistons by locked nuts or other means satisfactory to the Bureau. They shall be threaded on the other ends for attaching to the crosshead, and the extreme end of the rods shall be notched to suit a taper pin inserted through the cross head and the notched end of the rods to prevent the rods from backing out.

2. The piston rods shall be provided with wrench flats adjacent to crossheads.

S47-1-s. Crossheads.

1. Crossheads shall be of the split type, unless otherwise approved.

S47-1-t. Stuffing boxes.

1. Stuffing boxes shall be machined uniformily for the entire depth within a tolerance of plus or minus .005-inch, and the accuracy of alignment between the box and the rod shall be sufficient to insure proper operation of the pump.

2. All stuffing boxes shall conform to Bureau of Engineering standard B-132 for steam pressure 300 pounds and below and liquid pressures 400 pounds and below; for pressures in excess of these, the depth of stuffing boxes may be increased for additional packing rings as necessary.

3. All stuffing box glands shall be set up by nuts working on studs.

4. The throat of all stuffing boxes shall be composition bushed.

5. Packing shall be in accordance with Bureau of Engineering standard B-153. All packing shall be of an approved brand.

S47-1-u. Pump cylinders and valve chambers.

1. Pump cylinders over 6-inches inside diameter shall be fitted with working liners, not less than seven thirty-seconds inch thick. These liners shall be in one piece and secured in a manner satisfactory to the Bureau.

2. Liners shall extend to the top of the cylinder, but may terminate at the bottom against a shoulder in the cylinder above the lower part. The width of this shoulder shall be approximately half the thickness of the cylinder liner.

3. All pump cylinders shall be so designed that the pistons and valves are easily accessible and fitted for overhauling without disturbing the framing, piping, or cylinders.

4. The covers of pump cylinders and valve chambers over 2-1/2-inches in diameter shall be flanged, and in all pumps when covers are removed, the openings left shall be large enough to withdraw the plungers and valves.

5. Care shall be taken that all cylinders and valve chamber passages are free and of ample size.

S47-1-v. Liquid and pistons.

1. Pump piston shall be fitted with followers secured by collar studs, and with the nuts prevented from backing off by split pins, or as approved.

2. The pistons shall be taper bored for the reception of the piston rods.

3. Pistons shall be fitted with approved type and brand of packing.

S47-1-w. Pump valves.

1. Rubber valves when used shall be made from a highly vulcanized rubber compound in accordance with Navy Department Specifications.

2. Pump valves shall be of the single disk type.

3. Valves shall be held concentric on their seats by studs or valve bolts secured in a manner satisfactory to the Bureau. The studs or bolts shall also carry the valve guards which shall be secured against backing off. The valves shall be held to their seats by light helical springs.

S47-1-x. Stroke index.

1. All pumps fitted with crossheads shall have the top and bottom of the full stroke plainly marked on adjacent fixed and moving parts. A suitable stroke indicator shall be fitted to the moving parts.

S47-1-y. Air chambers.

1. Air chambers shall be fitted on the suction and discharge side of all pumps, except when otherwise specified or approved.

2. The volume of suction air chambers shall be not less than 1.25 times the displacement of the liquid cylinder per single stroke.

3. The volume of discharge air chambers shall be not less than the displacement of the liquid cylinder per single stroke.

TESTS

S47-1-z. Hydrostatic tests.

1. Pump cylinders and valve chambers shall be tested hydrostatically to one and one-half times the rated pump discharge pressure.

2. Steam cylinders and valve chests shall be tested hydrostatically to one and one-half times the maximum designed boiler steam drum pressure.

S47-1-aa. Type approval test.

1. Tests for type approval will be authorized by the Bureau and conducted at the Engineering Experiment Station, Annapolis, Md., at the expense of the exhibitor. The same or separate units must be tested for each class of service as set forth in paragraph S47-1-d. The size, head, and capacity of the unit for type approval test shall be as arranged between the Bureau and the exhibitor.

S47-1-bb. Performance acceptance tests.

1. One pump of each type and size on contract, or contracts in hand at the same time for identical units with identical contract guarantees, as selected by the Bureau's inspector, complete, shall be given a test in the shop to determine the overall power or steam consumption of the unit under the conditions of the contract guarantees. This test may be conducted in the shop of the contractor or a subcontractor, as arranged with the Bureau. The test shall continue for at least 2 hours and shall demonstrate that the unit is satisfactory in all respects. On this test the unit shall handle the liquid at the capacity, suction lift or pressure; temperature and discharge pressure specified in the contract. The Bureau may consider waiver of overall steam consumption tests of direct acting steam pumps, provided pumps of identical type, design and size for similar operating conditions have previously been tested.

2. During the foregoing tests sufficient data shall be taken to prepare the following curves plotted against piston speed, double strokes per minute or r.p.m., copies of which shall be included on the type D finished plans.

(a) Total steam consumption or power input to motor.
(b) Indicated horsepower.
(c) Capacity, gallons per minute.
(d) Overall efficiency.
(e) Volumetric efficiency.

The above curves shall be obtained for 100, 75, and 50 percent of rated discharge pressure.

3. In addition all pumps on a contract shall be assembled with their driving units, either at the works of the contractor or of the subcontractor for a test sufficient to demonstrate harmony of assembly, accuracy of dimensions and alignment. This test may be conducted at low speeds or low pressure, if desired, but shall show a satisfactory assembly run of at least 30 minute duration.

4. All tests shall be made with the pumps discharging into an air bound receiver in which the pressure is maintained constant at a pressure equal to the rated discharge pressure of the pump. Test of the pump in which the pump discharges through a throttling valve into an open tank will not be acceptable.

S47-1-cc. Ship tests.

1. After installation aboard ship, alignment shall be carefully checked and a running test made to check practical performance.

SPARE PARTS AND TOOLS

S47-1-dd. Spare parts.

1. All spare parts, except spare piston rings, shall be finished and fitted ready for use and arranged for stowage in accordance with Subsection S31-1.

2. Interchangeability among the sets of spares provided for service maintenance of a given number of similar units on any vessel, or groups of similar vessels on the same contract, shall be positively assured.

3. The following spare parts shall be furnished to each vessel, for each size and type of pump, to be carried on board and included in penalty weight:

Parts as Applicable to Pumps Furnished

Number similar pumps per vessel	1	2	3	4	5	6	7	8
1. Piston rods and nuts, complete	1	1	1	1	2	2	2	2
2. Pump rods and nuts, complete	1	1	1	1	2	2	2	2
3. Valve stems and nuts, including valve and link rods and tappet nuts complete	1	1	1	1	2	2	2	2
4. Pump valves, with backing plates, guards, bolts, and springs complete sets	1	2	3	4	5	6	7	8
5. Steam piston rings for main and valve pistons, 0.010-inch diameter oversize and rough turned, complete sets	1	1	1	1	2	2	2	2
6. Bearings, sleeve type, complete sets	1	1	1	1	2	2	2	2
7. Bushings, including throat bushings, complete sets	1	1	1	1	2	2	2	2
8. Drive chain and/or pinion (motor driven pumps)	1	1	1	1	2	2	2	2
9. Ball bearings, complete sets	1	2	3	4	5	6	7	8
10. Main steam valve chest liners	1	1	1	1	2	2	2	2
11. Auxiliary steam valve chest liners	1	1	1	1	2	2	2	2
12. Main steam valve piston	1	1	1	1	2	2	2	2
13. Auxiliary steam valve piston	1	1	1	1	2	2	2	2
For salt water pumps only								
14. Discharge valve seats, complete sets	1	1	1	1	2	2	2	2
15. Suction valve seats, complete sets	1	1	1	1	2	2	2	2

S47-1-ee. Tools.

1. One complete set of special wrenches shall be supplied for each machinery compartment in which the pumps are to be installed. Each special wrench shall be indelibly marked for the purpose intended. No ordinary commercial wrenches shall be furnished.

2. One complete set of special tools indelibly marked for the purpose intended shall be furnished for each vessel. A jacking device of a design that will not injure the polished surface of piston rods shall be included for pumps not fitted with crossheads.

NOTICE: See Amendments attached hereto

NAVSHIPS [illegible]

GENERAL SPECIFICATIONS FOR MACHINERY

Bureau of Engineering-Navy Department

August 1, 1939

SUBSECTION S47-2. - CENTRIFUGAL AND AXIAL FLOW PUMPS

(Superseding Subsection S47-2. - Centrifugal (Including Propeller Type) Pumps, Feed, Circulating, Condensate, Bilge, and Similar Services, Turbine or Motor Driven, for Water or Aqueous Saline Solutions, dated May 1, 1936).

GENERAL REQUIREMENTS

S47-2-a. Reference subsections.

Issue in effect including changes in effect on date of invitation for bids shall govern. (Copies obtainable only from the Bureau of Engineering).

41471

25. Alternating current motors and controllers and their shipboard Application..... 363-6
26. Pressure and vacuum gages..... 387-3
27. Thermometers..... 387-4
28. Bureau standard drawings.....Appendix I

347-2-b. Reference Navy Department Specifications (N. D. Specs.).

Issue in effect on date of invitation for bids shall govern. (Copies obtainable from the Bureau of Supplies and Accounts, Navy Department, Washington, D. C.).

1. Bearings, ball..... 42B5
2. Bolts, nuts, studs, and material for same..... 43B11
3. Bolt-studs, nuts and bars; steel (for service at temperatures up to 850° F.)..... 43B14
4. Brass, naval, rolled; plates, rods, shapes, sheets and strips..... 46B6
5. Bronze, valve; castings..... 46B8
6. Bronze, manganese; castings..... 49B5
7. Bronze, manganese; rods, shapes and plates..... 46B15
8. Bronze, phosphor; castings..... 46B5
9. Bronze, phosphor, rolled or drawn; rods, sheets and plates..... 46B14
10. Bronze, journal..... 46B9
11. Bronze, bearing, castings..... 46B22
12. Cocks, ground key..... 4505
13. Compound, rust-preventative..... 1404
14. Controllers, alternating current (shipboard use)..... 17C10
15. Gages, pressure, for direct stem mounting..... 4507
16. Gages, pressure and vacuum..... 4501
17. Iron, gray, high test (semi-steel); castings..... 46-1-5
18. Metal, anti-friction; ingots and castings..... 46M2
19. Metal, gun; castings..... 46M6
20. Motors and controllers, direct current (shipboard use).. 17M9
21. Motors, alternating-current (shipboard use)..... 17M10
22. Nameplates, instruction plates, and other designating markings for electrical and mechanical equipment..... 42N2
23. Nickel-copper alloy; castings..... 46M1
24. Nickel-copper alloy; rods, shapes, plates, sheets and strips..... 46M7
25. Nickel-copper-aluminum alloy; forgings, rods, strips and wire..... 46N5
26. Packing, rubber, cloth insertion..... 33P8
27. Packing, rubber, wire insertion..... 33P10
28. Packing, sheet, asbestos compressed..... 33P13
29. Phenolic material, laminated..... 17P5
30. Plates, boiler (marine)..... 48P2
31. Rods, welding, chromium-cobalt composition..... 46R5
32. Screws, machine (including screws, set)..... 42S5
33. Steel, castings..... 49S1

34. Steel, corrosion-resisting; rods, bars, billets and forgings.. 46818
39. Steel, forgings for hulls, engines and ordnance..... 4962
36. Steel, forging for nitriding and nitrided steel..... 46830
37. Steel, shapes, and bars for hull construction including material for drop and miscellaneous forgings..... 4681

847-2-c. General design.

1. The principle of reliability is paramount and no compromise to this principle shall be made with any other basic requirements of the design. It is the intention of this specification to obtain pumps of such a design that they will operate over a long period of years with a minimum of servicing. Where wear or erosion is unavoidable the parts subjected to such wear or erosion shall be of the best materials available for the purpose in order to reduce these detrimental effects to a minimum. The design and construction of all pumps shall be the most compact consistent with the following requirements listed in order of their importance.

(a) Reliability
(b) Accessibility for repair
(c) Resistance to wear or corrosion
(d) Economy

2. All pumps shall be of a type and make which has satisfactorily passed a test for type approval (See par. 847-2-aa), in accordance with the standard requirements for its class as set forth in paragraph 847-2-d following. For conditions governing type approval see Section A1.

3. In purchasing a pump and its driving unit under these specifications the following information will be necessary to define fully the characteristics of the pump desired; such information will be stated in the requisition or order.

(a) Classification as per paragraph 847-2-d following and whether horizontal or vertical.

(b) Type of drive, and characteristics of power supply:

(1) Turbine, direct connected or geared, horizontal or vertical. (See Subsections 550-1 or 550-2). Steam pressure and temperature, exhaust pressure.
(2) Motor and controller, horizontal or vertical, direct current (See Subsection 563-3 and N. D. Spec. 17M9); alternating current (See Subsection 563-6 and N. D. Spec. 17M10 covering motors, and 17C10 covering controllers, including classification of motor and control equipment).

(3) Type of drive coupling, i.e., reduction gear, direct closecoupled, direct motor drive through flexible coupling, etc.

(c) Capacity in gallons per minute. For contract purposes this shall be understood to mean the capacity of the specified liquid pumped, at the specified maximum temperature, as determined by calibrated meter, or other approved means, at the pump discharge beyond the point of turbulence.

(d) Characteristics of liquid to be pumped:

(1) Description
(2) Maximum specific gravity
(3) Maximum temperature.

(e) Total dynamic head, in feet of liquid pumped, or the equivalent pressure in pounds per square inch. For contract purposes this shall be understood to mean the difference between the elevation corresponding to the pressure at the discharge flange of the pump and the elevation corresponding to the vacuum or pressure at the suction flange of the pump, corrected for the same datum plane, plus velocity head at the discharge flange of the pump minus the velocity head at the suction flange of the pump. The velocities to be used in calculating the velocity heads shall be those calculated by dividing the capacity by the cross sectional area of the pump nozzles at the gage connections. The total dynamic head defined above is the algebraic sum of the total dynamic discharge head and the total dynamic suction head (or lift). When calculating the discharge head to be specified for a prospective installation the following factors are considered:

(1) Static discharge head; pressure corresponding to the vertical distance from the horizontal centerline of the pump first stage impeller to the elevation at which the liquid is to be discharged. This may be negative, if the delivery point is below the pump.

(2) Discharge friction loss in piping from pump to point of delivery.

(3) Pressure of liquid in receiving vessel, at the point of discharge, into which pump discharges.

(4) Velocity head at the pump discharge flange.

(f) Total dynamic suction head (or lift), in feet of liquid pumped or the equivalent pressure in pounds per square inch gage (or absolute pressure if lift is involved). For contract purposes this shall be understood to mean the corrected reading of a calibrated pressure or vacuum gage connected at the pump suction, referred to the horizontal centerline of the pump first stage impeller when the pump is handling the specified capacity of the required liquid at the specified temperature and discharge head. When calculating the total dynamic suction head (or lift) to be specified for a prospective installation the

following factors are considered:

(1) Static suction head (or lift); pressure corresponding to the vertical distance in feet from the horizontal centerline of the pump first stage impeller to the surface of the liquid from which the pump takes suction.

(2) Friction and entrance losses in suction piping.

(3) Pressure (or vacuum) of liquid in the vessel from which pump takes its suction (if any).

(4) Velocity head at suction flange of pump.

For classes D-1 and D-2 pumps the static suction head or submergence and the vacuum or absolute pressure in the condenser or evaporator shell shall be specified in lieu of the suction lift.

(g) For class C-3 bilge pumps and other pumps for which self priming is specified, the following additional information is required (See paragraph 847-2-12).

(1) Minimum air removal capacity expressed in cubic feet of air per minute measured at the vacuum.

(2) Maximum vacuum expressed in inches of mercury.

(3) Temperature of sealing water for primer, 60°F., unless otherwise specified.

(h) The size and location of the suction and discharge connections or a statement that these shall be as approved.

(i) The operating conditions for which the overall steam or power consumption is to be stated in bids and guaranteed in the contract, and penalties (as liquidated damages) for excess steam or power consumption.

(j) Limits of height, length, and width for the unit and for disassembly of unit for normal maintenance overhaul.

(k) Maximum and/or minimum weight allowed and, if necessary, penalty (as liquidated damages) for excess weight over the guarantees.

(l) A statement as to whether or not clockwise (right hand) and counterclockwise (left hand) units are required, and if not, that all units shall be to the same hand. Direction of rotation of a horizontal pump shall be determined by standing at the driving end and facing toward the pump; for a vertical pump by looking down upon the top of the pump.

(m) A complete list of all items of equipment, not essentially parts of the pump, which the pump contractor is required to furnish. Usually mention shall be made in such a list of spare parts and pressure-regulating governors; see paragraph 347-2-o. Also the following items should be considered if it is desired to have the pump manufacturer or contractor supply same.

(1) Relief valves.
(2) Drain valves.
(3) Suction and discharge valves.
(4) Check valves.
(5) Pressure and/or vacuum gages.
(6) Thermometers and thermometer sockets.
(7) Permanently connected revolution indicators.
(8) Air or vent valves and cocks.
(9) Special tools and number of sets per vessel.
(10) The number and distribution of instruction books and finished plans.
(11) Insulation and lagging.
(12) Other similar items.

4. The overall steam or power consumption of a pumping unit when operating under conditions specified in the order shall be stated in the bid and guaranteed in the contract.

5. The weight of the pumping unit complete with spare parts, but excluding sparepart boxing, shall be stated in the bid and guaranteed in the contract.

6. Each pump shall be installed with approved type of pressure gage on discharge and compound gage on suction.

347-2-d. Classification.

1. Classification and description of standard services for which centrifugal pumps may be specified, or approved, for the naval service are set forth in the following table, which is to be used as a guide when ordering and when submitting designs for type approval in accordance with paragraph 347-2-c and paragraph 347-2-uu.

CLASSIFICATION OF CENTRIFUGAL PUMPS BASED ON USUAL SERVICE APPLICATION AND CHARACTERISTICS 847-2

CLASS	SERVICE	Rated Capacity Gallons per minute	Rated Total Head Pounds per square inch	Liquid Handled	Minimum Suction Head or Maximum Suction Lift and Maximum Liquid Temperature	Parallel Operation Required	Horizontal or Vertical	Type of Drive	Preferred Design
A	Boiler feed pumps	100 to 1000	400 to 750	Clean fresh water	2 feet head and 150°F. to 25 lb. head and 350°F.	Yes	Horizontal	Direct connected turbine	Single stage, double suction for heads to 425 pounds. Multi-stage - single or double suction for heads above 425 pounds.
B	Main condenser circulating pumps	3,000 to 40,000	10 to 30	Sea water	10' Hg. lift with minimum of 4 feet stable submergence - 90°F.	No	Either	Direct connected or geared turbine	Axial or mixed flow.
C-1	Miscellaneous circulating and supply pumps	10 to 10,000	10 to 100	Fresh water Sea water Refrigerating brine	4 foot head - 90° to 140° as specified	As specified	Either	Direct connected motor or direct connected or geared turbine	Single stage, single or double suction, volute.
C-2	Fire or combined fire and flushing pumps	100 to 1,500	150	Sea water	8 foot head - 90°F.	Yes	Horizontal	Direct connected, turbine or gas turbine and motor drive	Single stage, double suction, volute.
C-3	Bilge pumps	100 to 1,000	50	Sea water, fuel oil, dirt and sediment. Maximum specific gravity 1.04	20" Hg. lift at 90°F.	No	Either	Same as C-1	Single stage, single or double inlet - self priming.
D-1	Condensate and evaporator brine overboard pumps	15 to 1,000	25 to 70	Clean fresh water - evaporator brine - sea water specific gravity 1.04	More than 15 inch submergence from vacuum of 1 to 2 p.s.i. absolute and corresponding temperature	Yes	Either	Same as C-1	One or two stage, single inlet, volute.
D-2	Condensate pumps	15 to 1,000	25 to 70	Clean fresh water	15 inch or less submergence from vacuum condition as for D-1	Yes	Vertical	Same as C-1	One or two stage single inlet, volute.
E	Feed booster pumps	25 to 1,000	30 to 100	Clean fresh water	6 foot submergence from feed tank water 0 to 15 p.s.i. pump suction, 210 to 250°F. temperature	Yes	Either	Same as C-1	One or two stage single or double inlet, volute.

2. When class C-1 or C-2 pumps are required to be self priming they shall be designated as "Class C-1 (or C-2) self priming". (See subparagraph S47-2-kk-9 following).

3. Where the combination of bilge pumping service with other services falling under class C-1 or C-2 is approved, such pumps shall be designated as "C-1 and C-3" or "C-2 and C-3" as applicable. (See subparagraph S47-2-aa-1 following).

4. Pumps for use on drain systems handling hot water at or near boiling temperature shall be designated as "Class E special".

S47-2-e. Mounting bedplates and installation.

1. Each pump and its driving unit complete with all appurtenances shall be mounted on a common bedplate (sideplate for bulkhead mounting).

2. Bedplates (and sideplates) shall be of cast steel, class C, Navy Department Specification 4981, or structural steel fabricated by welding.

3. Bedplates (and sideplates) shall be sufficiently rigid to permit handling, shipment and installation of the unit on board ship, without disturbing the alignment of the assembled unit, and the installation on board ship shall be such that normal distortion, swaying or vibration of the supporting structure cannot cause misalignment between the pump and its driving unit.

4. All bearing and seating surfaces of bedplates (and sideplates) shall be finished machined.

5. Each component part of an assembled unit supported directly by the bedplate shall be doweled thereto to facilitate reassembly and maintenance of alignment.

6. The design and installation of all pumps shall be such that alignment will not be disturbed or undue stresses set up in any part by normal vibration, contraction and expansion of piping attached thereto in service.

7. When motor driven pumps of the close coupled type are specified, a bedplate will not be required; however, the pump casing shall be provided with a supporting foot for bolting to foundation to augment the support from the motor frame. Where such construction is approved special attention shall be given the design to insure that leakage from the pump stuffing box gland and between shaft and shaft sleeve cannot enter the motor frame or bearing brackets.

SPECIAL REQUIREMENTS

S47-2-f. Drawings and instruction books.

1. Drawings and instruction books shall conform to the requirements of Subsection S1-1.

2. The assembly plans furnished with types B and D drawings shall show all parts assembled in correct position, each part being identified by a part number. This assembly plan shall contain a material list in which shall appear the names of every part identified by part numbers in numerical sequence, with the number of the drawing on which each part is detailed.

3. The assembly plan shall show all assembly clearances.

4. A table of pump and driving unit characteristics and a table of weights shall be shown on assembly drawings.

5. The assembly drawing of turbine driven pumps shall include a cross-section view of both the pump and turbine including reduction gears if furnished whenever a common or rigid coupled shaft is used.

6. Complete characteristic curves based on performance acceptance tests shall be included on type D drawings.

7. Instruction books shall be furnished for the following pumps:

Boiler feed
Main circulating
Main, cruising and auxiliary (dynamo) condensate
Main, cruising and auxiliary feed booster
Fire or combined fire and flushing
Bilge and other pumps fitted with self-priming units.

8. Instruction books shall contain:

(a) Pump and driving unit characteristic data.
(b) General information, serial numbers of pumps and driving units, and weights.
(c) Full, clear and concise description of the pump and its driving unit including controllers and pump pressure regulating governors as applicable, suitably divided with sufficient photographs, drawings and sketches to indicate clearly all parts referred to. Part numbers and nomenclature shall correspond to those shown on the assembly drawings.

(d) Operating instructions for starting, stopping and operation.
(e) Safety precautions and procedure in case of difficulties which may be anticipated, methods of disassembly and reassembly, repair and maintenance.
(f) Performance curves based on test data.
(g) List of finished drawings by number and legend, leaving space for insertion of Bureau plan numbers after each.
(h) List of all parts identified by drawing and part numbers.

847-2-g. Materials, workmanship and welding.

1. Materials, workmanship and welding shall conform to the requirements of Subsection 81-2.

847-2-h. Threaded parts.

1. Threaded parts such as bolts, studs and nuts shall conform to the requirements of Subsection 81-3.

847-2-i. Preservative coating.

1. Painting shall be in accordance with the requirements of Subsection 819-1.

2. All openings shall be closed against the ingress of moisture and foreign matter during stowage and shipment.

3. Internal non-machined surfaces, ports, etc., shall be cleaned thoroughly of all scale, corrosion, molding sand, welding beads or other such substance which might become detached in service.

4. All finished surfaces including shaft journals, stuffing boxes, etc., liable to rust or corrode shall be covered with a rust preventative compound, type A, grade II, in accordance with Navy Department Specification 14C4, upon completion of acceptance tests and before shipment.

847-2-j. Designating and marking.

1. Designating and marking shall conform to the requirements of Subsections 828-1 and 828-2.

2. Nameplates and rotation plates or cast arrows shall be provided on all pumps prominently located and securely attached thereto.

347-2-k. Heat insulation and lagging.

1. Casings of pumps handling water at a temperature in excess of 180°F shall be insulated and lagged in accordance with the requirements of Subsection 339-1.

2. Special care shall be taken to insure that the lagging is properly jointed to permit repair and inspection work such as opening of casings, without destroying the integrity of the covering.

347-2-l. Radial bearings.

1. Bearings may be of sleeve or ball type except for class A or class B pumps where sleeve bearings only are acceptable. The use of ball bearings on shafts in excess of 2-inches diameter is, in general, not acceptable unless specifically approved.

2. Ball bearings and their installation shall be in strict accordance with Subsection 343-4 and Navy Department Specification 42B5.

3. Bearings shall be installed in housings separate from and independent of the stuffing boxes and with adequate protection from gland leakage. Suitable means shall be provided to prevent the escape of oil around the shaft. All baffles, wipers, etc., shall be readily renewable.

4. Sleeve bearings for horizontal pumps may be of the fixed or self aligning type, as approved. The bearings shall consist of a cap and bearing shells, supported by a bracket integral with the pump casing, carried on a shoulder machined thereon, or held in alignment therewith by at least two heavy dowels and securely bolted thereto. The use of bolts alone for securing these brackets is prohibited. The bearing shells shall be split along the axis and so arranged as to permit lifting off the upper halves readily and to permit rolling out the lower halves without removal of the shafts. The bearings shall be neatly fitted in their seating to prevent axial play. Bearings and their seatings shall be finished machined.

5. Sleeve type bearings for vertical pumps shall be of split design with removable caps, so fitted as to permit renewal or refitting without removal of pump rotor from the casing. When specifically approved, vertical steady bearings of the bushing type will be accepted if wear will be slight and if made of non-seizing and non-scoring material.

347-2-m. Thrust bearings.

1. A suitable thrust bearing shall be installed on each pump for counteracting any unbalanced hydraulic or mechanical thrust in either direction. In this connection consideration shall be given to the fact that rolling, pitching, or list of a ship at sea may introduce thrust loads in a horizontal unit which is in hydraulic balance.

2. Thrust bearings for pumps may be of the following types:

(a) Straight thrust ball type.
(b) Combined radial and thrust ball type.
(c) Pivoted segmental type.

3. Ball type thrust bearings shall be in strict accordance with Subsection 343-4 and Navy Department Specification 4285. Where ball type thrust bearings are installed on shafts carrying single inlet impellers the bearings shall have a load rating at least 300 percent in excess of the actual thrust load. This load rating shall be as tabulated in Navy Department Specification 4285, based on a standard life of 4000 hours.

4. The straight thrust ball type bearings shall not be used in units over 100 horsepower or where the speed of the shaft is in excess of 1200 revolutions per minute. For class A pumps the pivoted segmental type only is acceptable.

5. Combined radial and thrust ball bearings shall preferably be type C, class b or c, single row, angular contact, duplex mounted, in accordance with Navy Department Specification 4285.

6. When pivoted segmental type thrust bearings are used, the design shall be such as to permit renewal or refitting of shoes without removal of the shaft.

7. For vertical pumps thrust bearings shall be installed at the top of the unit.

347-2-n. Lubrication.

1. A simple positive and self contained lubricating system shall be provided on each pump assembly, which, so far as practicable, shall conform to the general requirements of Subsection 345-1.

2. Where forced lubrication is provided, the gear oil pump and its suction shall be located below the level of oil in the lubricating oil drain tank under all conditions of operation including inclined operating conditions.

3. All thrust bearing housings, particularly those of the pivoted segmental type, shall be so designed that the thrust bearing will be adequately lubricated immediately the shaft starts to turn. This shall be accomplished by properly locating oil supply and drain pipes, and adequate sealing of the bearing housing so that regardless of the length of time the unit is idle an adequate supply of oil will remain in the bearing housing.

4. Where the use of ball bearings is approved the lubrication requirements of Subsection S45-4 and Navy Department Specification 4295 shall govern.

5. Where forced feed lubrication is provided, external oil coolers will be required. These shall be of approved type and in accordance with Subsection S45-1. Coolers shall be arranged so that oil may be by-passed and water shut off to permit replacement of tube nest or cooler without interruption of operation of the unit being served.

6. Internal cooling coils when permitted for ring or disk lubricated bearings shall be continuous (without joints) and readily removable as a unit. All connections thereto shall be external. They shall be supported throughout their length to prevent rupture due to bending or vibration. Cooling coils shall be designed to withstand a hydrostatic test pressure of 225 pounds per square inch gage. The use of cored water spaces in bearing housings for cooling will not be approved.

S47-2-o. Pump pressure regulating governors.

1. One pump pressure regulating governor of an approved type and in accordance with Subsection S47-6 shall be furnished with each turbine driven pump for the following services:

(a) Boiler feed.
(b) Fire and flushing, except when dual motor and turbine drive is specified.

2. Contractors are cautioned to take into account steam pressure drop through pump pressure regulating governors when rating turbine driven pumps. (See Subsection S47-6).

S47-2-p. Piping and valves.

1. The requirements of Subsections S48-1, S48-2, and S48-6 shall apply except as hereinafter modified.

2. All flanges and fittings for pipe connections shall conform to the standards of the Bureau of Engineering. (See Bureau drawing S-2-554).

3. All valves shall conform to the standards and/or specification of the Bureau. (See Bureau drawing 6-Y-654).

4. When two or more pumps are arranged to run in parallel, a check valve shall be installed in the discharge pipe from each pump to prevent back flow through a pump that is not up to pressure.

S47-2-q. Turbines.

1. All turbines for driving pumps shall be in accordance with the requirements of Subsections S50-1 and S50-2. Attention is directed particularly to the requirements regarding approved designs.

S47-2-r. Feed systems.

1. The requirements of Subsection S56-2 shall apply.

S47-2-s. Motors and controllers.

1. All motors for use with centrifugal pumps shall be of constant, adjustable speed or multispeed as specified or approved, and shall conform to the requirements of Subsection S63-3 for direct current, or S63-6 for alternating current motors.

2. Motor rotors for use on dual turbine and motor driven class C-2 pumps shall be designed and tested for a speed 25 percent in excess of rated turbine speed.

S47-2-t. Pressure and vacuum gages.

1. The requirements of Subsection S87-3 shall apply.

S47-2-u. Thermometers.

1. The requirements of Subsection S87-4 shall apply.

S47-2-v. Other Subsections.

1. The requirements of all other referenced Subsections (paragraph S47-2-a) shall be met.